AD-A129 735 RECONNAISSANCE REPORT FOR HYDROPOWER LOCK AND DAM 8 MISSISSIPPI RIVER(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 81 1/2

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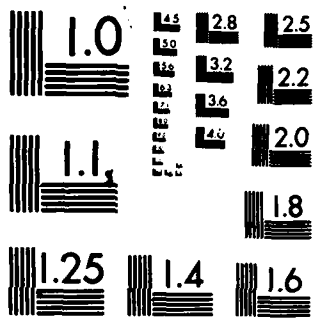

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This report presents a preliminary evaluation of the addition of hydropower at the existing navigation lock and dam 8 on the Mississippi River. The study shows installation of a hydroplant with 8,750kW nameplate rating is economical. This system would produce an average evergy equivalent of 85,000 barrels of oil or 24,000 tons of coal per year.

RECONNAISSANCE REPORT
FOR HYDROPOWER

LOCK AND DAM 8
MISSISSIPPI RIVER
NEAR GENOA, WISCONSIN

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PERTINENT DATA

LOCK AND DAM 8, GENOA, WISCONSIN

Normal upper pool (feet)	Elevation 631.0
Normal minimum tail water (feet)	Elevation 620.0
Nominal lift (feet)	11.0
USGS gage number	05-3785
Location	Winona, Minnesota
Gage drainage area (square miles)	59,200
Project drainage area (square miles)	64,770
Project pool area (acres)	20,800
Maximum flood flow (April 1965) (cfs)	274,000
Average flow (cfs)	28,900
Median flow (cfs)	20,200
Minimum flow (August 1934) (cfs)	3,300
Roller gates (80 by 20 feet)	5
Top of roller gate sill (feet)	Elevation 611.0
Tainter gates (35 by 15 feet)	10
Top of tainter gate sill (feet)	Elevation 616.0
Top of earth dike (feet)	Elevation 639.5
Top of lock wall (feet)	Elevation 639.0
Flood crest, pool (April 1965) (feet)	Elevation 639.18
Flood crest, tail water (April 1965) (feet)	Elevation 638.38

PROPOSED HYDROPOWER PLANT

	Option		
	10 units	12 units	16 units
Total nameplate capacity (kW)	8,750	10,500	14,000
Dependable capacity (kW) (July-August)	6,400	7,300	8,000
Dependable capacity (kW) (December-January)	7,700	8,700	9,300
Plant factor	.61	.58	.51
Average annual energy (MWh)	46,600	53,200	62,300
Construction first cost ($1,000)	26,280	-	-
Benefit-cost ratio	1.28	-	-

UNIT DESIGN PARAMETERS

Turbine type	Horizontal propeller turbine with adjustable blades
Runner diameter	118.1 inches (3.0 meters)
Design head	9.5 feet (2.9 meters)
Minimum head	3.3 feet (1.0 meter)
Design flow	1,260 cfs/unit
Generator nameplate capacity	875 kW
Turbine efficiency	.89
Speed increaser efficiency	.99
Generator efficiency	.98

RECONNAISSANCE REPORT
FOR HYDROPOWER

LOCK AND DAM 8
MISSISSIPPI RIVER
NEAR GENOA, WISCONSIN

SYLLABUS

This report presents a preliminary evaluation of the addition of hydropower at the existing navigation lock and dam 8. The study shows that installation of a hydroplant with 8,750 kW (kilowatt) nameplate rating is economical. Pertinent data concerning the site and potential hydropower installations are ~~shown on~~ the facing page.

Severe environmental impacts are not necessarily associated with construction of a plant of the sizes investigated despite the proximity of the lock and dam to an environmentally sensitive area. Hydropower is one of the most ecologically sound means of producing electricity because it uses a nonpolluting, renewable energy source - water flow - allowing nonrenewable energy sources to be conserved.

The energy available at lock and dam 8 can be an important contribution to our Nation's energy independence. An 8,750-kW system would produce an average energy equivalent of 85,000 barrels of oil or 24,000 tons of coal per year.

The District Engineer recommends that the Corps of Engineers prepare a feasibility report which can serve as a basis for congressional authorization for hydropower plant construction at lock and dam 8.

Lock and dam 8

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NEAR GENOA, WISCONSIN

STUDY AND REPORT

SCOPE OF THE STUDY

The studies presented in this report represent preliminary reconnaissance level detail. The purpose of the report is to deterr whether a feasibility study should be conducted. Significant time and .rces can be invested in a feasibility study; thus, a decision to proceed with a study should be based on a finding that a potentially viable project can be developed. Therefore, the reconnaissance study is a relatively complete small-scale feasibility investigation in which the issues expected to be important in the feasibility stage are raised, and a first cut economic analysis is performed. A favorable reconnaissance level finding is a strong indication that further detailed study (a feasibility study) is warranted subject to assessment of potentially critical issues.

STUDY AND AUTHORITY

Recognizing the importance of continued and successful operation of completed projects, Congress provided the Corps with the authority to study possible modifications to existing projects. This authority is contained in the House Committee on Public Works resolution, dated 11 December 1969, which requests the Corps of Engineers:

> ". . . to review the reports of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River . . . with a view toward determining whether any modifications of the existing project should be made at this time in the interest of providing increased flood control, and for allied purposes on the Mississippi River."

COORDINATION AND STUDY PARTICIPANTS

Agencies and interests were informed of the initiation of the study and were invited to participate. A copy of the notice and pertinent responses are included in Appendix B, Coordination.

Primary participants in the study include the Federal Energy Regulatory Commission (FERC), Fish and Wildlife Service (FWS), and the St. Paul District, Corps of Engineers. Under the Federal Power Act and other legislation, FERC has broad responsibilities related to planning, construction, and operation of water resource projects, particularly in regard to power development. One of those responsibilities is establishment of values for power that might be produced at lock and dam 8. Correspondence related to power value determination is included in appendix B.

The FWS, under the authority of the Fish and Wildlife Coordination Act, is the primary agency from which the Corps of Engineers will obtain Federal fish and wildlife resource data and planning input. The FWS has provided preliminary comments regarding a potential hydropower project at lock and dam 8. Its planning aid letter is included in appendix B.

The Department of Energy (DOE), Office of Power Marketing Coordination, is responsible for all marketing of Corps-produced power. This office will be contacted during the feasibility study regarding distribution of power that may be produced at lock and dam 8.

The St. Paul District, Corps of Engineers, is chiefly responsible for this study and the report. The reconnaissance report will be distributed to all interested Federal and State agencies and the public. Comments received will help guide future efforts during the feasibility study.

STUDIES OF OTHERS

The Corps of Engineers is completing the National Hydropower Study; ... dam 8 is one of the sites investigated.

The National Hydropower Study was authorized by Section 167 of the Water Resources Development Act of 1976 (Public Law 94-587). The study will provide a general but comprehensive appraisal of the potential for incremental or new hydropower generation at existing dams and other water resource projects, as well as undeveloped sites in the United States. Preliminary results of that study, which is being managed by the Institute for Water Resources of the Corps of Engineers, show a benefit-cost ratio of 0.97 for a hydropower addition of 16 MW at lock and dam 8.

Dairyland Power Cooperative has also appraised the hydroelectric potential at lock and dam 8. The study was prepared by Commonwealth Associates in a report titled "Genoa Hydroelectric Project Appraisal Study," November 1979. Dairyland Power did the economic analysis. The results indicate that hydroelectric development of 10 MW at lock and dam 8 may be feasible from a technical, environmental, and economic standpoint. Because of required coordination of the hydroelectric facility with Mississippi River navigation and Corps of Engineers ownership of the existing dam, Dairyland has indicated that it may be appropriate for the Corps of Engineers to develop and operate hydroelectric facilities at the existing navigation dams with Dairyland purchasing the energy output from the Corps-owned facilities.

THE REPORT AND STUDY PROCESS

Results of the reconnaissance study are contained in this report including recommendations that a feasibility study be conducted.

The reconnaissance study was started in July 1981 and culminates with this report. Much of the information presented here was derived from the study at lock and dam 7 which was initiated in February 1980. If approved by Corps of Engineers higher echelons, the feasibility study for hydropower addition at lock and dam 8 will begin in fiscal year 1983 and will be completed in spring 1985. The final feasibility report would be submitted to Congress which could authorize a hydropower project at lock and dam 8. However, the authorization, advance planning, and funding by Congress are necessary before any recommended actions could be taken.

PROBLEM IDENTIFICATION

EXISTING CONDITIONS

Location

Lock and dam 8 is located on the Mississippi River at river mile 679.2 above the mouth of the Ohio River. It is near Genoa in west-central Wisconsin. and is one of the 13 navigation locks and dams built in the 1930's along the Upper Mississippi River in the St. Paul District. The dam and dike which connect the Minnesota and Wisconsin shorelines creates almost 21,000 acres of lake which is a very valuable aesthetic, recreation, and biological resource.

Structural Integrity

The stability and structural integrity of lock and dam 8 are good. The latest periodic inspection in 1978 revealed no major deterioration of the dam or dike. The foundation soil consists largely of rounded grey sand of varying size (see the boring logs on plate 3) mixed with silt and some gravel to at least a depth of 74 feet. This soil should provide a stable and competent foundation for the proposed structures and should not present any problems during dewatering and construction.

Long-term ongoing erosion both upstream and downstream of the gated concrete dam section has been occurring since the structure was built in the 1930's. This scour has resulted in lowering the river bottom elevation up to 20 feet upstream of the dam and up to 60 feet downstream of the dam, with slopes averaging 1V on 3H, beginning just off the structure and extending to the toe of the scour.

The existing scour poses no threat to the stability of the concrete dam; however, because the erosion is continual, remedial measures may have to be taken some time in the future. These measures might include the ...nt of fill in the scour holes and extending the existing riprap above and below the dam.

Hydrologic Conditions

The flow available for power at lock and dam 8 is estimated from 50 years of gage data at Winona, Minnesota (USGS 05-3785). This gage is at river mile 725.7 from the mouth of the Ohio River, and is 46.5 miles upstream of lock and dam 8. The total drainage area upstream of the project is 64,770 square miles, which is 9.4 percent greater than the area upstream of the gage. The La Crosse and Root Rivers are tributary to the Mississippi River between the gage and the site. The average monthly flows at Winona, Minnesota, are shown in the table below.

Average monthly flows, Mississippi River at Winona, Minnesota

Month	Flow (cfs)	Month	Flow (cfs)
January	13,600	July	28,200
February	13,800	August	19,000
March	27,300	September	19,800
April	58,100	October	19,000
May	45,400	November	19,900
June	37,500	December	15,500
Annual average flow	28,900	Median flow	20,200

Environmental Setting

Physical Setting - The main geographic feature of the region is the Mississippi River valley. In the study area the valley ranges from 2 to 5 miles in width and is bordered by bluffs rising 400 to 500 feet above the river level. At lock and dam 8, the valley is 2.5 miles wide and the river channel occupies the eastern one-fourth mile of the valley.

The climate is humid continental with wide temperature extremes and about 29 inches of precipitation annually.

Terrestrial Resources - The woodlands in the area can be divided into two general groups: the upland xeric southern forests of Wisconsin and Minnesota and the southern lowland vegetation of the floodplain.

The study area provides habitat for a very diverse assemblage of plants and animals and is a noted feeding and resting area for a variety of migratory waterfowl. Much of the floodplain area in pools 8 and 9 is managed as part of the Upper Mississippi River Wild Life and Fish Refuge.

Established natural areas within the study area are: West Channel Woods, Waller Lake Floodplain Forest, Lower Goose Island, Turtle Nest Islands, Forsters Tern Colony, Crosby Slough, and Mouth of Rush Creek. All are managed by the Wisconsin Department of Natural Resources.

Aquatic Resources - The Mississippi River within the study area is impounded by lock and dam 8 at Genoa, Wisconsin, and by lock and dam 9 at Lynxville, Wisconsin, to form navigation pools 8 and 9 of the waterway system. The Root and La Crosse Rivers are tributaries to pool 8 and the Bad Ax and Upper Iowa Rivers are tributaries to pool 9.

In general the water quality of the Mississippi River is good. Two potential sources of poor water quality would be the La Crosse Municipal sewage treatment plant and the Dairyland Power nuclear generating station. Both these sources are currently well within compliance standards.

Pools 8 and 9 are reported to have 86 and 80 species of fish, respectively. Important sport fishing areas include the tail water below lock and dam 8 and the area near the wing dams. The commercial fishery in both pools is of economic significance with pool 9 having the largest commercial harvest of all pools on the upper Mississippi River. Some commercial clamming is also done in pool 9.

The wetland system in the Mississippi River floodplain provides outstanding habitat and is largely responsible for the abundance and diversity of fish and wildlife resources in the study area. These wetlands are widely recognized as significant resources and are protected by Federal, State, and local laws.

Significant Facilities - The nuclear power plant at Genoa, Wisconsin, and the National Fish Hatchery 4 miles downstream of lock and dam 8 are listed as significant because of their close proximity to the dam and their reliance on river water for operation.

Cultural Resources

The Mississippi River valley has been occupied from about 12000 B.C. to the present. Historically, the valley has been the site of the earliest European and American settlements.

There are three recorded archeological sites within three-fourths mile of lock and dam 8. No sites currently on or eligible for the National Register of Historic Places are located in the immediate lock and dam area.

Recreational Resources

The Reno Bottoms area near lock and dam 8 is one of the most significant sport fishery and waterfowl resources of the Upper Mississippi River. The area also supports a considerable amount of boating. In 1980, pool 8 supported about 1,422,000 hunting and fishing occasions and 282,000 boating occasions.

Population Centers

The nearest population centers to the project are La Crosse, Wisconsin (48,300), and Winona, Minnesota (25,100). These areas are located 15 and 40 miles, respectively, from lock and dam 8.

A more thorough discussion of the environmental setting of the project is presented in appendix E.

CONDITIONS IF NO ADDITIONAL FEDERAL ACTION IS TAKEN

If no Federal hydropower is recommended and subsequently developed, one of two futures is probable. One future is no action or no change from existing conditions. This case would have no environmental or social impacts other than those expected under present conditions. However, with no action, several opportunities will be forgone including utilization of a renewable and environmentally clean energy source and capitalization on a relatively economical source of energy.

A more probable alternative future is the development of lock and dam 8 for hydropower by someone other than the Federal Government. Low cost federally financed loans for feasibility studies and licensing are available for investigation of hydropower development at existing dams. Even though lock and dam 8 is federally owned, non-Federal entities may apply for hydropower licensing at a Federal site. In addition, Federal low interest loans for construction are available to small rural communities and certain non-profit organizations for such developments. Thus, if the Federal Government does not add hydropower to lock and dam 8, some other interest will probably add it because ample incentives appear present.

A list of competing applicants for a Federal Energy Regulatory Commission (FERC) permit to develop hydropower facilities at lock and dam 8 follows.

Application number	Applicant	MW	MWh
3622	Mitchell Energy, Inc.	14	86,000
4426	City of St. Charles, Minnesota	14	86,000
4434	Wisconsin Public Power Inc.	-	-
4500	City of New Ulm, Minnesota	10-20	35,000-70,000
[illegible]	Western Wisconsin Municipal Power Group	4-14	22,500-72,000

Impacts of non-Federal development would probably not differ appreciably from those that would occur with Federal development.

PLANNING CONSTRAINTS

Any possible hydropower development plan proposed for lock and dam 8 must be technically and economically sound, environmentally acceptable, and capable of being implemented. Technical factors include constraints that:

1. The plan fit in with the geometric configuration of the existing structure and not adversely affect navigation, which is the principal and primary purpose for lock and dam 8.

2. The plant must operate as a run-of-river facility chiefly to eliminate adverse environmental effects.

To be recommended for further study, the selected plan must be economically justified. In other words, the benefits of the installation must outweigh the costs for construction and maintenance.

Possible adverse impacts on wild and scenic rivers, historic sites, endangered species, migratory fish, wildlife, and other environmental amenities must be assessed. Significant impacts should be eliminated if possible and mitigated when they cannot be eliminated.

PLANNING OBJECTIVES

The "Principles and Standards for Planning Water and Related Land Resources" require that all federally assisted water resource projects be planned to achieve these national objectives:

- National Economic Development (NED) - Enhance the Nation's economy by increasing the output of goods and services and improving national economic efficiency.

- Environmental Quality (EQ) - Minimize adverse impacts and enhance the quality of the environment by conserving, preserving, or restoring natural and cultural resources.

The social well-being and regional development accounts are also important and will be considered in the planning process.

To address these national objectives, the specific objectives of this study are to:

1. Increase the national economic efficiency through the development of a less costly energy source, thus helping to reduce dependence on foreign fuels in the Nation and study area.

2. Enhancement of the environment by reducing the use of nonrenewable fossil fuels in the Nation and the study area, resulting in conservation of those resources.

3. Minimize site-specific environmental effects of hydropower development.

ANALYSIS OF PRELIMINARY ALTERNATIVES

PLAN FORMULATION RATIONALE

The purpose of plan formulation is to evaluate alternative measures for fulfilling the national and specific planning objectives. For this reconnaissance report, formulation is not based on detailed technical evaluation but is based to a large degree on professional judgment. The level of detail for this report is only designed to answer whether a feasible [illegible] probably be developed and whether the study should be continued. If warranted, feasibility studies will commence, and alternatives will be more thoroughly evaluated.

An interdisciplinary team was assembled to develop a strategy for selecting a site along the dam and adjoining dike at which installation of hydropower might be most practical from all viewpoints of the team. After the site was selected, an evaluation was made of different scales of development and use of different machinery to find the most cost effective and least environmentally damaging measures. The following sections provide more details on how the preliminary plan for hydropower addition at lock and dam 8 was developed.

LOCATIONS CONSIDERED

Lock and dam 8 is supported on timber piling, driven in sand and gravel, with steel sheet-piling cutoff walls. The main lock is 110 feet wide and 600 feet long; the upper gate bay of an auxiliary lock is provided in the event it becomes necessary to add another lock in the future. The movable dam section consists of 5 roller gates 80 feet wide by 20 feet high and 10 tainter gates 35 feet wide by 15 feet high. A service bridge spans the entire length of the movable dam and storageyard, providing for the operation of the crane and flat car. An earth dike, 15,720 feet in length with a 20-foot roadway at its crest, completes the dam along the Minnesota side of the river. Along the dike are two fixed crest concrete spillways totaling 2,275 feet in length. The site plan is shown on plate 1. Consideration was given to locating the hydroelectric plant at several sites along the area described above.

To be cost effective, hydropower development must use the maximum flow available in the Mississippi River. Placing the power plant at the earth dike or spillway would require construction of a very large channel through the Upper Mississippi Wild Life and Fish Refuge. The channel was believed to be too costly and damaging to the environment to merit further consideration. The area in the storage yard adjacent to the tainter gates and the portion of the dike adjoining the storage yard was considered. This area would accommodate more traditional construction methods and plant designs

compared with those probable in the tainter gate bays. Hydropower development in this area would probably not affect navigation. The storageyard area was identified as the best location for a powerhouse in the report "Genoa Hydroelectric Project Appraisal Study" by the Dairyland Power Cooperative.

In some respects, the auxiliary lock which was never completed for navigation would be a good site for hydropower units. The auxiliary lock could be dewatered relatively easily for the construction of the hydropower plant and its proximity to the main lock control station would aid in the monitoring of the facility and maintenance after construction. In addition, a design for the auxiliary lock could be applied at other locks and dams along the Mississippi River with unused auxiliary locks. However, the large amount of flow which would pass through the auxiliary lock might adversely affect navigation. A model study of the hydropower plant located in the auxiliary lock would be necessary; funding and time allotted for the reconnaissance did not allow such an in-depth evaluation. For this reason and because using the auxiliary lock for hydropower would eliminate the future option of its use as a navigation lock, the site at the auxiliary lock was eliminated from consideration, at least for this preliminary stage of study.

A hydropower plant in the existing movable gates was also considered. A standard powerhouse in the gate bays was not selected though because of the small number of gates (5 roller and 10 tainter gates). All of these gates may be needed to pass high flows. However, liftable hydropower units attached to the tainter gates may have merit. The Schneider hydroengine and the Allis-Chalmers powerhouse gate are two such units. Because of head and flow characteristics, an Allis-Chalmers 3-meter horizontal tube turbine was used in the analysis of all the alternatives. Installation of this turbine or the Schneider engine as liftable units, however, would result in inadequate turbine intake submergence. The concrete slab of those tainter gate bays used for hydropower would have to be removed; this would likely be costly and would affect the stability of adjacent gate piers. For this reason and because neither the Allis-Chalmers unit or the Schneider engine have been field tested as part of a movable gate system, this alternative was not considered further in the reconnaissance study.

The site selected for a preliminary analysis was the area in the storage yard and the adjoining portion of the dike. A thorough evaluation of power plant sites, including use of smaller liftable units in the tainter gate bays, will be made during the feasibility study.

HYDROLOGIC POWER AND ENERGY ANALYSIS

Background

Following is a shortened discussion of the hydrologic power and energy analysis found in appendix C of this report. For further information consult appendix C.

The production of power from the force of falling water follows from basic principles of physics. Work (energy) can be expressed as a force moving through a distance. In the case of hydropower production, the force is the weight of the water, and the distance is the vertical fall, or "head," which is the difference between pool and tail-water elevations.

Power is the rate at which the energy is produced. Expressed as kilowatts:

$$P = \frac{Q.H.e}{11.82}$$

, where Q represents flow in cfs and H represents the head in feet, minus entrance and exit losses. The factor "e" represents the combined efficiency of the turbine, speed increaser, and generator. For preliminary calculations involving modern machinery, an average efficiency of about 0.86 is often used.

Power is the rate of production of energy, so the total energy produced in a given period is found by multiplying the average power during the period, in kilowatts, by the length of the period in hours.

E = Power (kW) x time (hours) = kilowatt-hours (kWh)

Sometimes energy is expressed as megawatt hours (MWh) or gigawatt-hours (GWh):

$$1 \text{ MWH} = 1{,}000 \text{ kWh}$$
$$1 \text{ GWh} = 1{,}000{,}000 \text{ kWh}$$

Since the flows at a given site are usually quite variable, it would be useful to store excess volumes for use during lower flow periods. The St. Paul District's navigation dams have only minimal storage available (pondage). For several reasons, including navigation, environment, recreation, and business interests, pool fluctuations are kept to a minimum; and without pool fluctuations, the useful storage is negligible. An allowable fluctuation range of 0.4 foot would give about 8,000 acre-feet of storage, which would give about 7 hours of operation for the proposed 8.75-MW plant. This would give some daily "peaking" capability, but it will not allow storage of high flows for later use. This type of plant, with low available storage capacity (pondage), is called a "run-of-river" plant.

Average Annual Energy

The power capacity and energy production for run-of-river plants can be adequately predicted from the flow-duration curve. Daily flow values for the period of record are grouped into flow classes. Each flow class is then plotted according to its cumulative percentage of occurrence. The result is the flow-duration curve shown in figure A.

The gross head was reduced by the estimated trash rack and tailrace losses to produce the curve of net head shown on figure A. Each flow class is assigned an average head for the class. Higher flows cause a reduction in head at lock and dam 8.

Production of power would cease when the head drops below approximately [illegible] which corresponds to a flow greater than 60,000 cfs. A flow of 60,000 cfs has an 85-percent chance of being exceeded at least once in a year, and on the average will be exceeded 35 days per year.

For each flow class along the flow-duration curve, the power is calculated for the available flow or capacity, whichever is less. If the available average head is different from the design head, the turbine flow is calculated by the "orifice equation" to be proportional to the square root of the ratio of the available head to the design head.

The product of the head and flow gives the power; the power is then multiplied by the duration of the flow class (in hours) to find the estimated energy. Summation of the energy of all the flow classes, i.e., the area under the power curve, gives the average annual energy (AAE) for each option.

Within the head and flow constraints, three optional plant capacities were selected to allow analysis of significantly different levels of development. In plate C-1, the power curves have been plotted for the three options considered. The ratio of the average load on the plant to the plant capacity, called the plant factor, has also been calculated. A table of average annual energy and plant factor for each option is presented below.

Average annual energy for lock and dam 8

Plant capacity (MW)	AAE (MWh)	Plant factor
8.75	46,600	.61
10.5	53,200	.58
14.0	62,300	.51

Dependable Capacity Evaluation

Dependable capacity (firm power) is that capacity which can be relied upon (on the average) during a certain period. It is of interest to know the dependable capacity for the year and for critical load (demand) periods. The critical load periods for this region are July-August and December-January. The dependable capacity can be thought of as the size of conventional plant which would replace the hydro plant to provide the same dependable

capacity, on the average. The dependable capacities for each option are shown in the table below. For a more detailed discussion of method, see appendix C.

Dependable capacity (MW) for lock and dam 8

Period	Plant capacity option		
	8.75 MW	10.5 MW	14.0 MW
July-August	6.4	7.3	8.0
December-January	7.7	8.7	9.3
All year	6.3	7.2	8.4

Weekly Power Generation

Estimates for weekly power generation were done to provide input for determination of project benefits. The procedures used are outlined in appendix C.

HYDROPOWER PLANT SIZES CONSIDERED

As previously discussed, three optional scales of development were considered to better optimize the project: plant capacities of 8.75, 10.5, and 14 MW. Because Allis-Chalmers tube turbine units are standardized and appeared to be most economical for low-head applications, the three levels of development were based on using those units. A 3.0-meter (9.84-foot) runner diameter unit was selected, primarily because of head and flow characteristics. Each unit could produce 875 kW at a rated head of 9.5 feet. Therefore, the 3 scales of development would use 10, 12, and 16 of the standard 3-meter units to produce 8.75, 10.5, and 14 MW, respectively.

As previously stated, the site site selected for the powerhouse is the storageyard area and adjoining dike. However, only 10 of the hydro units be accommodated in this area.

Benefits were estimated for all three optional plant capacities, but a cost analysis was prepared only for the 10 unit option. Locations for additional hydropower units will be more thoroughly evaluated in the feasibility study.

ECONOMIC ANALYSIS

Economic feasibility analysis compares economic costs with project benefits. The comparison is made using a common value base. Costs and benefits are stated in 1981 dollar values and this fixed price level is used for valuing future costs and benefits. The time frame used for the benefit-cost analysis begins in 1990 when the project is assumed to be installed and extends through the 100-year economic life of the project to 2090. A 7 3/8-percent interest rate is used.

Basis for Measuring Power Value

The Chicago Regional Office of the Federal Energy Regulatory Commission did the benefit analysis. In its 10 September 1981 letter to the St. Paul District (appendix B), benefits were calculated as follows.

Power values are the benefits produced by a hydroelectric plant and are based on the surrogate costs of constructing and operating the most likely alternative if the hydroelectric project is not constructed.

Using a coal-fueled steam-electric plant as the most likely alternative to the proposed hydroelectric project, power values are summarized in the following table. These are "at market" values; no transmission line costs for the hydroelectric development have been included. All values are based on January 1981 levels.

Power values include "capacity value" plus "energy value." Capacity value is based on the investment cost (annualized) necessary to construct the most likely alternative. Energy value is the net savings in generating costs of a hydroelectric plant over the most likely alternative. The current energy values were escalated to recognize real cost increases projected for fuel.

Power value summary - lock and dam 8, Mississippi River
(January 1981 cost base and 7 3/8-percent interest rate)

Item	Hydroelectric units 10	12	16
Capacity, kW	8,750	10,500	14,000
Average annual energy, MWh	46,600	53,200	62,300
Unit capacity value, $/kW-year	100.00	93.70	67.40
Unit energy value, $/MWh			
Current	20.40	20.60	21.20
Escalated	41.40	41.80	41.90
Annual hydroelectric benefits			
Capacity benefit, $/year	875,000	983,800	943,600
Energy benefit, $/year	1,929,200	2,223,800	2,610,400
Total annual benefits	2,804,200	3,207,600	3,554,000

System operating costs for both the hydroelectric plant and the alternative steam electric plant were simulated using a probabilistic production costing computer model. The POWRSYM Version 48 production costing model was used for this analysis. Northern States Power Company was used as a "typical" system to measure operation costs.

Adjustment Factors Applied to Power Values

The capacity value includes a credit of 5.0 percent to reflect the greater operating flexibility (quicker start-up time) of the hydroelectric plant. The capacity value has also been adjusted to incorporate the relative availability of the hydroelectric plant capacity in comparison with the availability of the coal-fueled steam-electric plant alternative. The availability of the hydroplant is based on the amount of dependable flow; availability for a steam-electric plant is based on the probability of a breakdown. The relative availability of the 10-, 12-, and 16-hydro unit [illegible]ons results in 5, 11, and 36 percent debits, respectively, for these hydroelectric plant capacities.

Energy values are given based on both current fuel cost levels and on projected real fuel price increases. Escalated real fuel costs assume a 1990 project on-line date and a 7 3/8-percent cost of money to levelize them over the 100-year life of the hydroelectric plant. Real fuel cost escalation factors were taken from Department of Energy data published 23 January 1980 in the Federal Register, Part IX.

Benefit-Cost Comparison

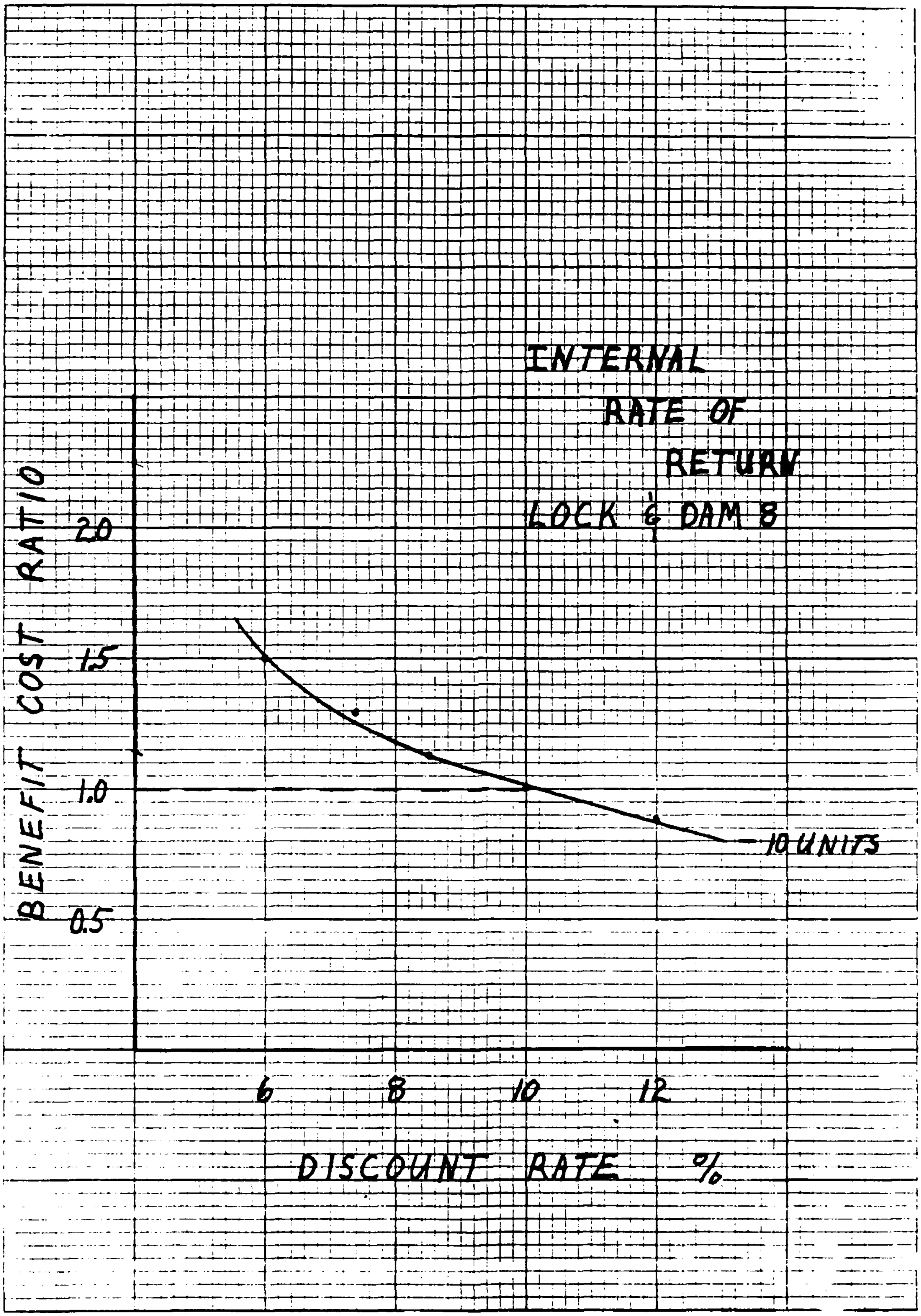
The following table shows annualized costs and benefits for the 10-unit hydropower plant. A breakdown of costs is presented in appendix A.

Average annual costs and benefits ($1,000)

Item	10-unit alternative
First costs	26,280
Total Federal investment (1)	28,174
Interest and amortization of Federal investment (2)	2,080
Operation and maintenance	106
Average annual costs	2,186
Average annual benefits	2,804
Net benefits	618
Benefit-cost ratio	1.28

(1) Includes first costs plus present worth of project rehabilitation at year 50; salvage value at year 50 and year 100; and interest during construction. See appendix A for itemization of costs.
(2) 100-year economic life at 7 3/8-percent interest rate.

The benefit-cost ratio is 1.28 and the net benefits are $618,000 for the 10-unit, 8.75 MW plant. The internal rate of return is 10 percent as shown on the following figure.


INTERNAL RATE OF RETURN LOCK & DAM 8
BENEFIT COST RATIO
2.0
1.5
1.0
0.5
10 UNITS
6
8
10
12
DISCOUNT RATE %

ENVIRONMENTAL IMPACTS

A brief discussion of potential project impacts and a list of issues that need detailed study are summarized here and presented in appendix E. A more detailed assessment will be made during the feasibility study.

No Action Alternative

There would be no direct impact on the existing natural resources of pools 8 and 9 if hydropower was not installed on lock and dam 8.

10-Unit Alternative

This alternative would place 10 hydropower units in the existing storage-yard area and adjoining dike on the west (Minnesota) side of the dam (see plate 1).

Impacts on Natural Resources

Construction Impacts - Impacts on natural resources would result from construction of head race and tailrace channels in and near the storage yard, placement and removal of cofferdams and barge landings, noise during construction, and construction of a transmission line corridor. The last item could have substantial effects on wetlands and may be a hazard to migratory waterfowl. Wildlife habitat may be disturbed near the construction area.

Operation Impacts - It is anticipated that impacts would be confined to the immediate vicinity of the dam as the hydropower operation would not alter existing storage or pool fluctuations.

Impingement of aquatic life and degradation of water quality are not expected to be significant problems. Mortality of fish passing through the turbines is expected to be minimal.

The existing tail water area of the dam provides good to excellent aquatic habitat. The effect of changes in flow distribution, current velocities, and sediment patterns on the tail-water area is unknown. The upstream movement of fish may be interfered with with the diversion of most of the flow through the turbines.

Any maintenance dredging of intake and exit channels may destroy benthic organisms and increase turbidity and sediment deposition.

Impacts on Cultural Resources

Most of the proposed construction areas were disturbed during construction of lock and dam 8. There is still the possibility that historical and/or archeological sites will be negatively affected by hydropower development, such as by the placement of barge landings.

Coordination has been initiated with the Wisconsin and Minnesota State Archeologists, the Minnesota and Wisconsin State Historic Preservation Officers, and the National Park Service.

Recreation Impacts

The proposed development should not significantly affect general boating in the area. A privately owned fishing float immediately downstream of the storageyard area on lock and dam 8 may have to be relocated.

Social Impacts

Social impacts could result from construction activity, noise, and dust. Social controversy could arise through selection of a transmission line corridor, dredged material disposal sites, inequitable distribution of project costs and benefits, and conflicts with recreation or management of wildlife and fish refuge lands.

Outstanding Environmental Issues Associated with Hydropower Development at Lock and Dam 8

The following is a list of environmental issues that deserve special attention in future planning efforts for hydropower development at lock and dam 8. Some of these issues have been identified as important by the Fish and Wildlife Service in initial coordination (see letter in appendix B). Further detailed studies are necessary to quantify existing resources that might be affected, better predict the type and magnitude of potential impacts, and develop appropriate plans for mitigating or minimizing adverse impacts.

1. Impacts of construction and operation on aquatic habitat.
2. Effects of altered tail-water flow patterns on fish populations and fish utilization of the lock and dam 8 tail-water area.
3. The potential for entrainment and impingement of adult fish, eggs, larvae, and young in the turbines and the resultant impact of increased mortality.
4. The impacts of transmission lines on migratory waterfowl.
5. The impacts of construction and operation on endangered species.
6. The effect of construction on social conditions in the affected area.
7. The effects of construction on any currently unknown cultural resources in the project area.

MECHANICAL AND ELECTRICAL FEATURES

General

A standardized packaged predesigned turbine-generator, tubular-type, would meet the hydraulic conditions at this site. Plate 2 illustrates the adaptation of information furnished for the Allis-Chalmers predesigned units. The units selected would be capable of delivering 0.875 MW each with a rated head of 9.5 feet. The major equipment furnished as part of each package would include generator, turbine, control panel, cubicle for metering equipment, intake gate speed increaser, coupling, blade positioner, and oil system.

Intake Structure

The existing lock and dam was built with provisions for 13 tainter gate bays; 3 existing storage bays would be used for this project. With 10 generating units used, 4 additional erection bays would have to be provided on the dike. The water passage configuration in the existing tainter valve structure is not completely compatible with the proposed units. Therefore, a concrete transition section, as shown on plate 2, would be used.

Mechanical Equipment

The on-off control of intake water would be by a tainter gate. The gate would be equipped for emergency closure upon loss of power. The operator would be arranged to lower the gate against full turbine runaway speed discharge. The bulkhead slots would be used if the operating gate requires maintenance.

An overhead bridge crane would be considered for maintenance of the turbines and generators. This would allow inspection of the runners without the need for a mobile crane.

Standard ceiling-type exhaust fans would be provided for powerhouse cooling. Because the generators are air-cooled, the fans would be sized to maintain temperature limits using outdoor air only.

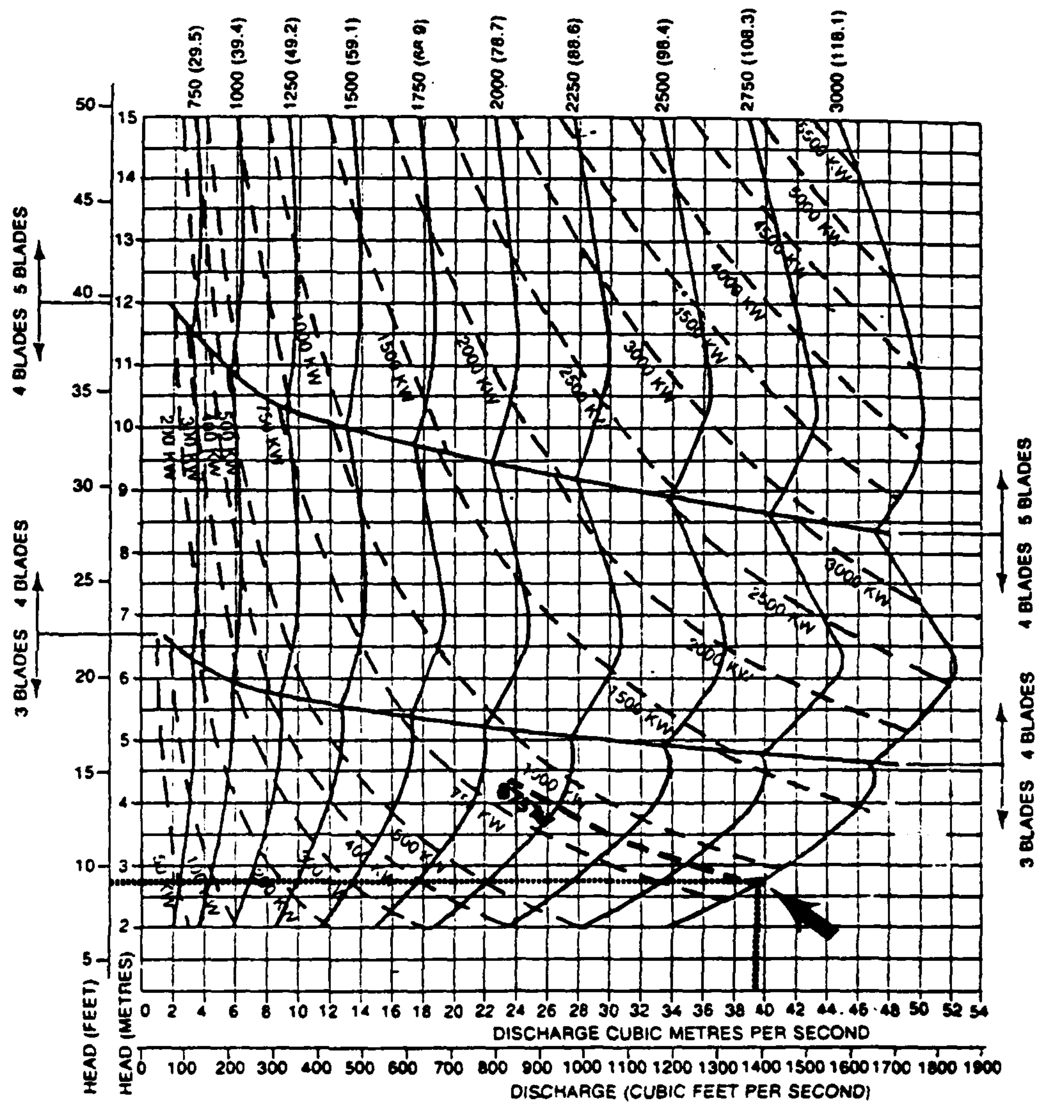
Two small submersible pumps would be provided for drainage and dewatering. Portable pumps could also be used for dewatering.

Turbine

An adjustable three-blade tubular turbine available from several manufacturers is considered because it is the largest standardized package unit which will fit the existing structure. The turbine has a throat diameter of 3,000 millimeters (118.1 inches). As shown in the following figure, at a rated head of 9.5 feet, generator output of the unit can be estimated at 900 kW. To account for possibly lower than advertised efficiencies and mechanical and transmission losses, an output of 875 kW per unit was adopted.

Sizing Chart

STANDARD *TUBE* TURBINE UNITS
OPERATING RANGES
750 mm to 3000 mm
GENERATOR OUTPUT IN KILOWATTS
TEN UNIT SIZES — MILLIMETRES (INCHES)



NOTE. OUTPUT BASED ON UNIT CENTERLINE SETTING OF ONE-HALF (½) RUNNER DIAMETER (DIA/2) ABOVE TAILWATER. CENTERLINE OF UNIT AT ELEVATION 150 m (500 ft.) ABOVE SEA LEVEL

Source; Figure 9 from Standardized Hydroelectric Generating Units by Allis-Chalmers.

Other turbines, such as bulb turbines and "Ossberger" cross-flow type turbines, may be suitable for this installation. All suitable turbine types will be evaluated during the feasibility study.

Generators and Breakers

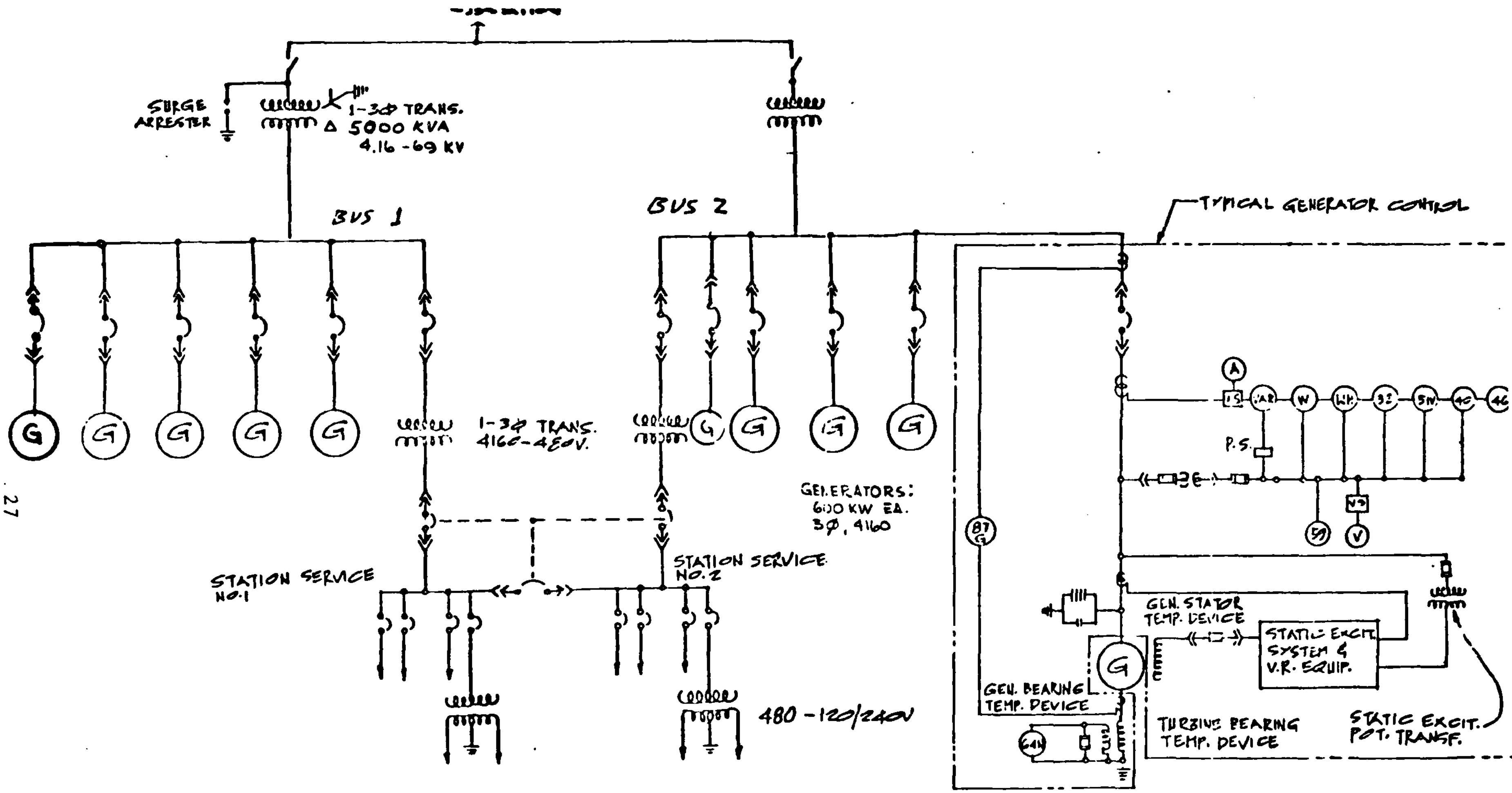
The generator would be a synchronous type, rated 1,000 kVA, 0.9 PF, 3-phase, 60 Hz, 4.16 kV, 900 rpm. A drip-proof guarded enclosure would be provided for the generator. The generator would have an 80° C rise Class B insulation system without provisions for overload. It would have full run-away speed capability eliminating the need for a disconnect clutch. The generator breaker will be a metal clad draw-out type rated 250 MVA (nominal), 5kV, 1,200 amp continuous. Breakers will be combined into metal clad switch-gear lineups common to groups of four units, also containing generator surge protection and instrument transformers as well as station service switchgear in two of the lineups.

Excitation System

The excitation system for the unit would be of the bus-fed, power potential source, static type, excitation power being derived from the generator terminals. During starting, the generator field will be automatically flashed (permitting generator voltage buildup) from a rectified A-C station service source.

Unit Control and Protective Equipment

A complete complement of generator protective relays (differential, over voltage, over current, etc.), start-up and shut-down controls, and other unit control relays would be provided in the metal-clad switchgear lineup containing the generator circuit breaker. Synchronizing would be accomplished by speed switches. The generator breaker would close at 95-percent speed with the static excitation system being energized at 98-percent speed. The generator would be provided with connected amortisseur to facilitate pull-in with the system. The packaged unit would have electrical and mechanical protective devices as indicated on the following one-line diagram.



MAIN ONE LINE DIAGRAM - L&D No.8 HYDRO STATION

Station Service

There would be two separate sources of station service power. One source would be bus tap between two generator circuit breakers and a main power transformer, and from a similar tap from the second bus as shown on plate 3. Station service switchgear would be arranged to provide full service from either source. Also, the former above source would supply station service from a single unit when generation into the utility system is shut down. Station service switchgear (4,160 volts) would be included in generator circuit breaker switchgear lineups. Station service power distribution would be at 480 volts 3-phase and 120/240 volts single phase.

Connection to Load

A 3-phase 69-kV overhead transmission line would tie directly to the local utility substation. The substation is located approximately 200 feet from the powerhouse site. The plant would have five generator step-up transformers with two units connected to each transformer. Each transformer would be rated 5,000 kVA, 69 kV "WYE" connected high-voltage winding, 4.16 kV "DELTA" connected low voltage winding, 3-phase, 60 Hz. The transformers would be bused together on the high voltage side through disconnect switches at the powerhouse for connection to the transmission line.

CIVIL FEATURES

This section describes the civil features pertaining to the installation of tube turbine power generating units at lock and dam 8. Civil features include the powerhouse, intake and exit channels, permanent access, impact on existing structures, and site work. A brief description of some important construction considerations is also included.

Two alternatives were investigated for the installation of power generating units at lock and dam 8. One alternative placed 10 horizontal tube turbines in the storageyard area. The other alternative investigated placing 10, 12, or 16 liftable horizontal tube turbines in the existing tainter gate bays.

Storage Yard Installation

Powerhouse - The powerhouse would be made of reinforced concrete and would house the power generating units and electrical equipment. Flow to the turbines would be regulated by tainter gates installed upstream of the turbines. Sheet-pile cutoff walls would be chosen at the upstream and downstream edges of the powerhouse to prevent undermining of the structure. Batter piles would be driven as part of the powerhouse foundation to insure that current stability criteria are attained. Trash racks with small openings would be installed upstream of the turbines to protect them from damage during operation. Stop-log grooves would be provided on the upstream and downstream edges of the structure so that individual pairs of turbines could be dewatered for maintenance.

The interior of the powerhouse would be totally open from one end to the other to provide maximum space for maintenance. The turbines and the associated mechanical and electrical equipment would be grouped in pairs located between the existing service bridge piers.

The roof of the powerhouse will be the surface of the storageyard. To provide the extra strength needed to support the storageyard loading, the powerhouse would have thicker walls and more reinforcing than the typical powerhouse.

Channels

Intake and exit channels would have to be excavated to accommodate turbine operations. The intake channel invert elevation is 618.0 and the discharge channel invert elevation is 603.5. The discharge channel invert elevation was determined by submergence requirements of the turbines selected. Concrete wing walls extending approximately 40 feet upstream and downstream of the powerhouse would be constructed to retain the difference in elevation between the invert elevation of the discharge channel and the existing ground elevation at the toe of the levee. Concrete guidewalls would be constructed between the end tainter gate and the upstream and downstream side of the powerhouse.

A sandfill training dike would be constructed upstream of the powerhouse to protect the dike against erosion.

Erosion protection requirements were developed to protect the intake and exit channels. The analysis for riprap design considered average inlet and outlet velocities, the possibility of flow concentration, and the possibility of local increase in shear stress at channel transitions such as elevation changes in the approach channels to the turbines. Proposed riprap location, thickness, and gradation are shown on plate 1.

Access

Permanent access for operation and maintenance of the powerhouse would be needed. This access must be usable during flooding of the Mississippi River. To provide permanent access to the powerhouse, a road would be built along the top of the dike extending from the Minnesota side of the river to the powerhouse site. Bridges designed for small vehicle traffic, constructed of precast concrete planks supported between steel supports, would be used to cross the two existing submersible dams located in the dike. A parking and turnaround area would be provided at the powerhouse. A lockable gate to prevent public vehicular traffic would be provided at the Minnesota end of the dike. Heavy or bulky items to be used in maintenance of the powerhouse would have to be transported to the powerhouse site by barge or raft.

Equipment to be used in the construction of the hydropower facility could be transported to the site by raft or barge or by constructing a temporary crossing at the submersible dam locations. The submersible dams were not designed to accommodate heavy vehicular traffic and should be bypassed by building temporary ramps to get on and off the dike and temporary crossings with culverts downstream of the submersible dams.

Impact on Existing Structures

Permanent impact on existing structures include the effects of providing access on top of the dike and the effect on the dam due to changing the flow pattern. Traffic on the dike would probably result in increased maintenance requirements for the dike. An agreement between the Corps of Engineers and the hydropower operating authority would have to be made to assign responsibility for the maintenance. The bridges would have a negligible effect on the flow over the submersible dams. The effect of changing the flow pattern through the lock and dam is unknown. The changing of the flow pattern could have either a beneficial or detrimental impact on the existing scour holes upstream and downstream of the dam. The scour holes are currently presenting a threat on the stability of the dam.

Site Work

The powerhouse would be underground except for the roof slab which would form the surface area of the storageyard. The storageyard would be returned to its original size and elevation. Restoration of the storageyard is essential to the operation of the lock and dam. The dike would also be restored to its original size and elevation in the areas where the dike is located over the powerhouse because such restoration is necessary for flood control.

Other site work would include fencing around the storageyard and the establishment of grass along the access road and around the parking area. Access to the powerhouse would be provided outside of the storageyard.

Construction

The following items must be considered during construction of the hydropower facility:

1. Dewatering would be required to construct the powerhouse. Upstream and downstream cofferdams would be placed to facilitate the dewatering. Placement of the cofferdams would be made more difficult by the proximity of the upstream and downstream scour holes. Because the soil is pervious, the dewatered area would have to be pumped.

2. A temporary storageyard would have to be provided, especially since the construction will take more than one summer.

3. Installation of the powerhouse between the storageyard piers would require special construction. Sheet pile would be driven around the piers as shown on plate 2. Steel ties would be installed as excavation progresses to provide support for the sheet piling. The sheet piling would remain in place to be used as forms for the powerhouse. This method of construction would be cheaper than replacing the piers.

Liftable Units

Liftable units were to be considered as an alternative for this report. The rationale for considering liftable units being that a feasible liftable unit developed for one site can be used at other lock and dam sites.

The standard 3-meter horizontal tube turbine produced by Allis-Chalmers could not be used as a liftable unit at the lock and dam 8 site. The upstream water depth at lock and dam 8 is 15 feet. Installation of the turbine with an adequate lifting frame would result in inadequate turbine intake submergence (assumed as 2 1/2 feet). Removing the bare slab of the tainter gate bay would be expensive and would affect the stability of the adjacent tainter gate piers. The Shneider Hydroengine was investigated as a possible liftable unit. However, the depth of the intake tube was 20 feet, precluding further investigation.

To make a liftable unit work at this site, a smaller unit, say a 2.5-m turbine could be used. Since power curves for a 2.5-m turbine had not been developed as a part of this report, a detailed plan for the liftable unit was omitted. Further investigation of a liftable unit could be done as part of a feasibility report.

CONCLUSIONS

This reconnaissance investigation establishes that hydropower development at lock and dam 8 is technically and economically feasible and would not necessarily cause significant environmental damage.

PLAN FOR FUTURE STUDY

The favorable finding of the reconnaissance study indicates that further detailed study (a feasibility study) is justified.

If a feasibility study is undertaken, it would formulate a small hydropower project, prepare an implementation strategy, and provide the basis for an implementation commitment. The significant institutional, engineering, environmental, marketing, and economic aspects will be assessed in support of the investment decision.

The feasibility study, if approved, would begin in fiscal year 1983 and be completed in spring 1985. The District's report would be sent forward to higher Corps echelons for review and then submission to Congress for authorization of the recommended plan. The figure in appendix D illustrates the procedure of approval of the feasibility report.

The level of detail envisioned for the feasibility study would provide a basis for direct development of plans and specifications for project implementation. Assuming prompt funding following congressional authorization, the plant would be completed 3 to 4 years after allocation of construction funds.

Appendix D outlines in detail a plan of study for the feasibility investigation.

EXECUTIVE ORDER 11988

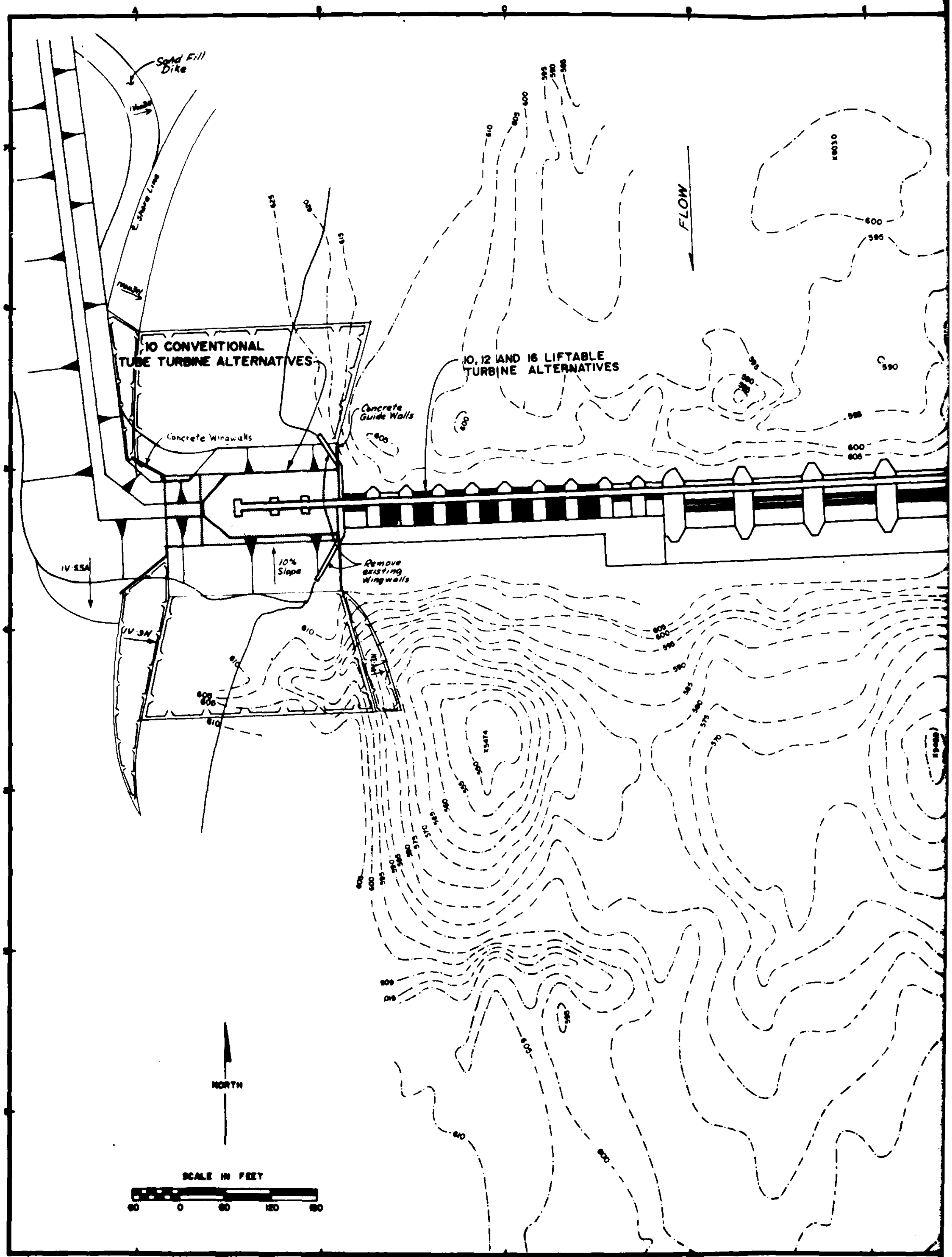
Executive Order 11988 requires Federal agencies to recognize the significant values of floodplains and consider the public benefits that would be realized from restoring and preserving them. It is the Corps' policy to formulate projects which, to the extent possible, avoid or minimize adverse impacts associated with the use of the floodplain and avoid inducing development unless there is no practicable alternative.

Development of hydropower at lock and dam 8 requires use of the floodplain for the hydropower facilities. There is no alternative in which floodplain land would not be affected. Hydropower development, however, will not induce floodplain development. Expected impacts on floodplain values are found in appendix E.

RECOMMENDATION

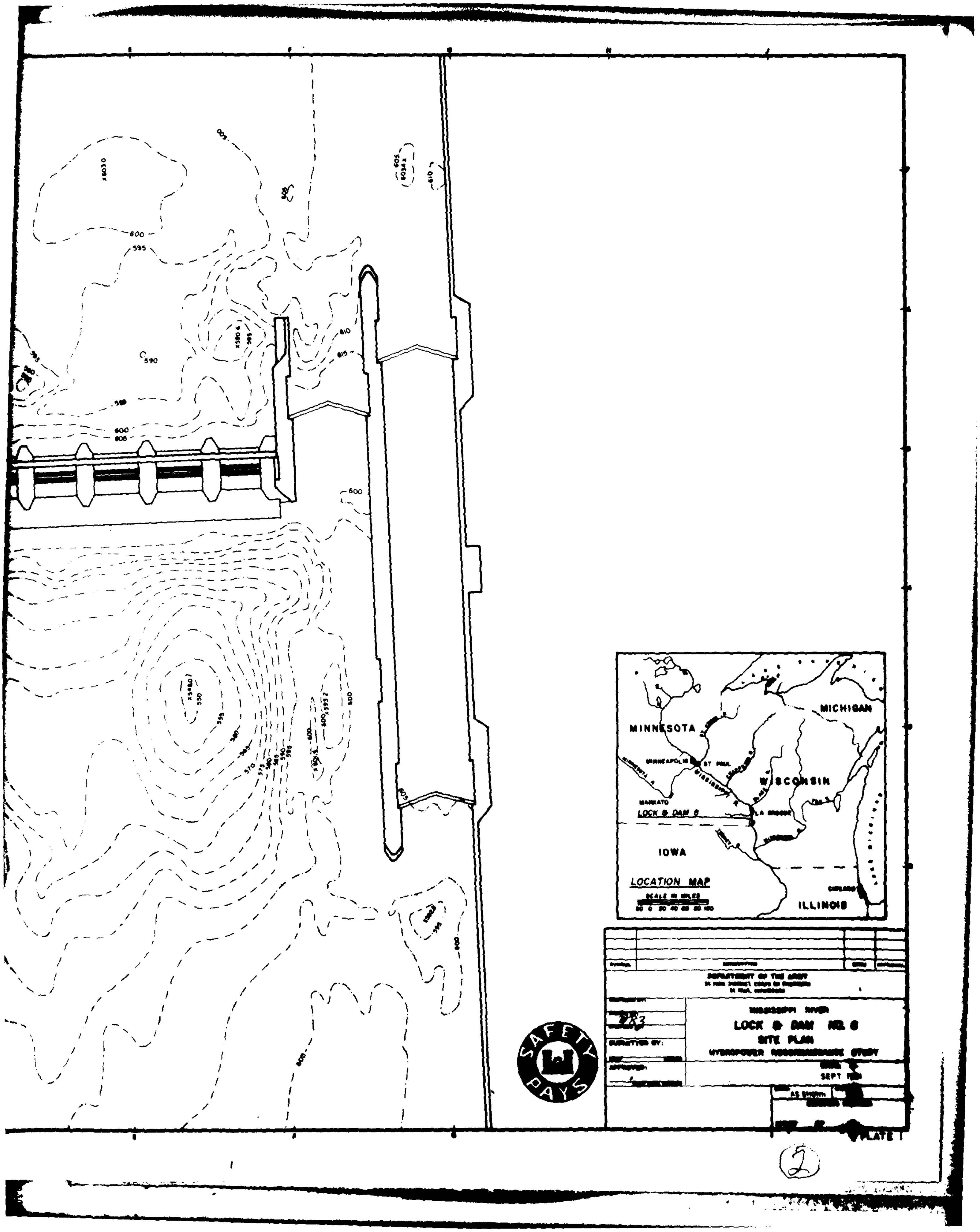
I recommend that a feasibility report be prepared and that it be allowed to begin in fiscal year 1983 and be completed in 2 years. I further propose that the report be comprehensive enough so it can be used as a basis for construction authorization by Congress.

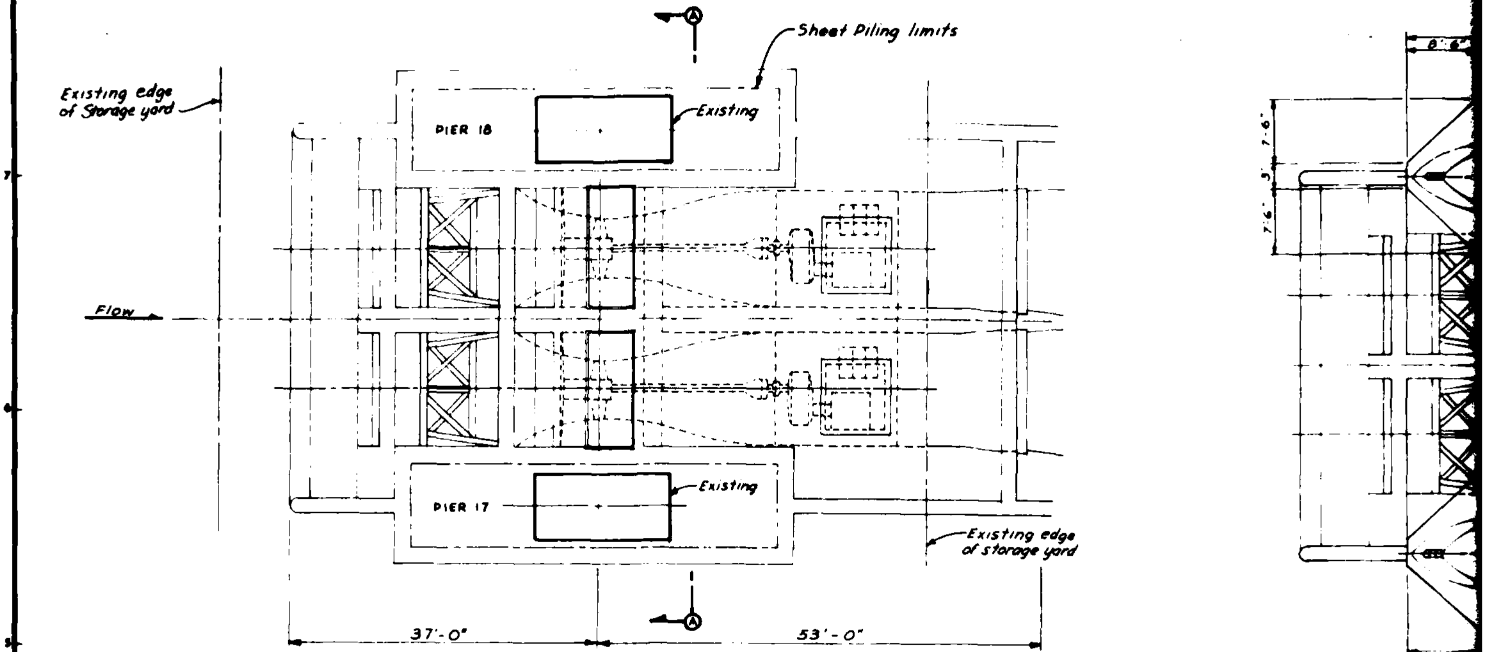
WILLIAM W. BADGER
Colonel, Corps of Engineers
District Engineer



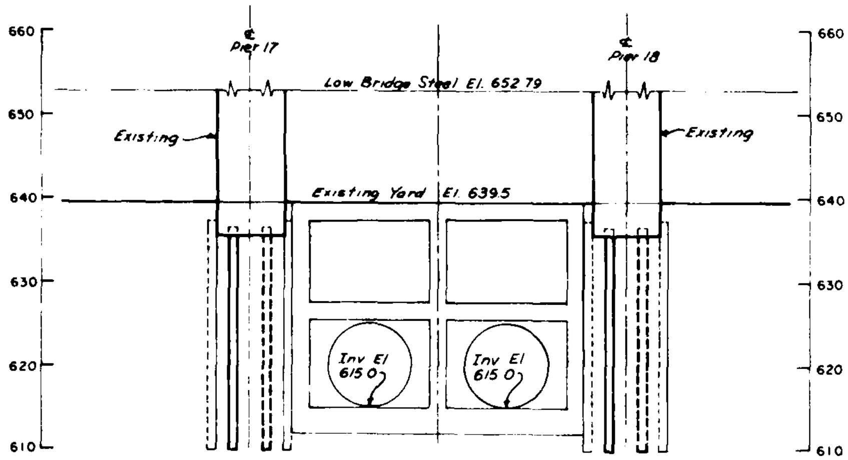
Sand Fill Dike
10 CONVENTIONAL TUBE TURBINE ALTERNATIVES
10, 12 AND 16 LIFTABLE TURBINE ALTERNATIVES
FLOW
Concrete Guide Walls
Concrete Wingwalls
10% Slope
Remove existing Wingwalls
1V:5.5A
1V:3N
NORTH
SCALE IN FEET
60 0 60 120 180

1


MINNESOTA
MINNEAPOLIS
ST PAUL
WISCONSIN
MICHIGAN
MANKATO
LOCK & DAM 6
LA CROSSE
IOWA
ILLINOIS
CHICAGO
LOCATION MAP
SCALE IN MILES
DEPARTMENT OF THE ARMY
MISSISSIPPI RIVER
LOCK & DAM NO. 6
SITE PLAN
HYDROPOWER RECONNAISSANCE STUDY
SUBMITTED BY:
APPROVED:
SEPT
AS SHOWN
SAFETY PAYS
PLATE 1



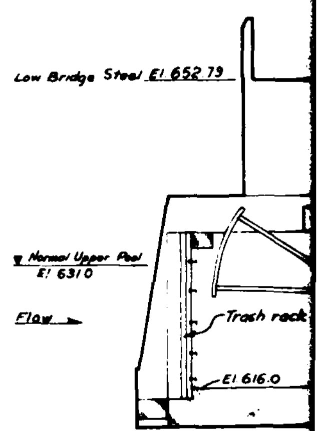
STORAGE YARD
PLAN
NOT TO SCALE

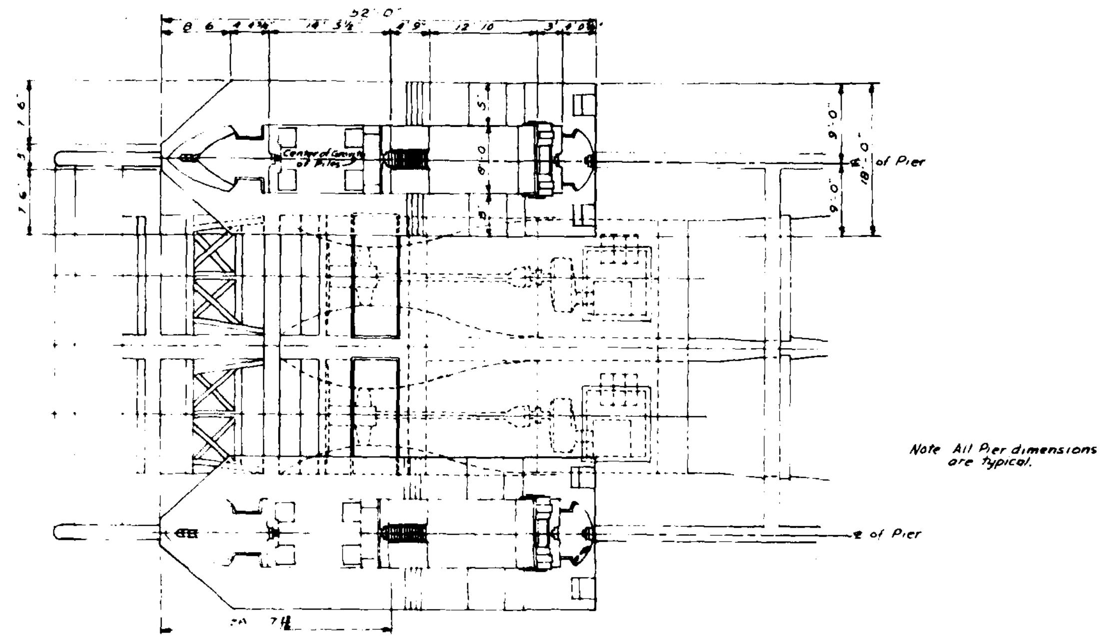


SECTION A–A

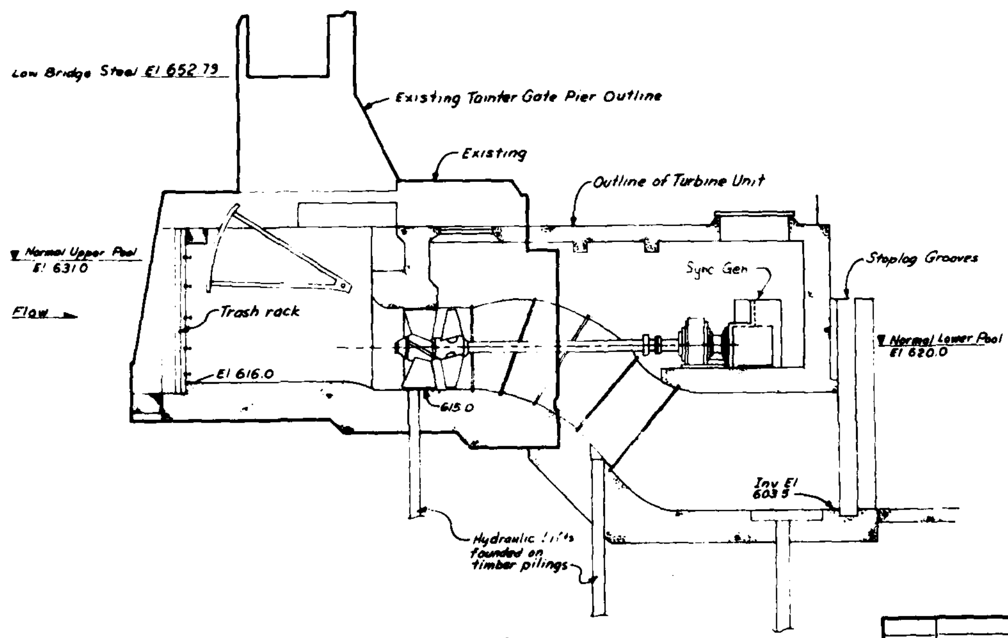
SCALE IN FEET

Notes
1. Sheet piling to be used along Bridge Piers tied to sheet piling on opposite side of Pier left in place.
2. Soil anchor tiebacks are used at Pier 19.
3. Pier 16 foundation at El 618 - no tiebacks are required.





PLAN
NOT TO SCALE



TAINTER GATE
ELEVATION SECTION
SCALE IN FEET

xisting edge
storage yard

Piers tied to
left in place
r 19
backs are

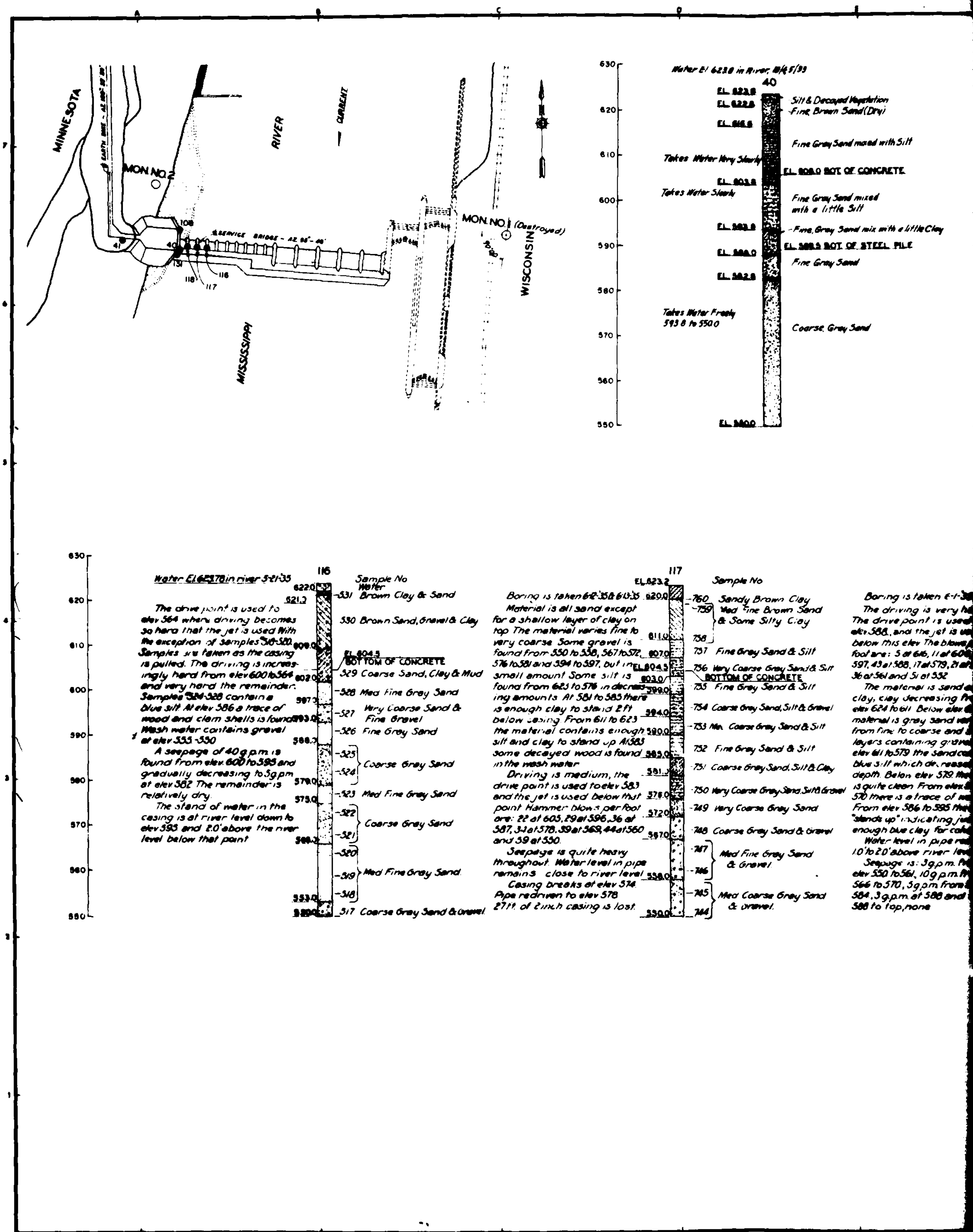
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

S P L	MISSISSIPPI RIVER
J C A	LOCK AND DAM NO. 8
S P L	TYPICAL SECTIONS
SUBMITTED BY:	HYDROPOWER RECONNAISANCE STUDY
APPROVED:	DATE: SEP 1981
	SCALE: AS SHOWN
	DRAWING NUMBER
	SHEET OF

SAFETY PAYS

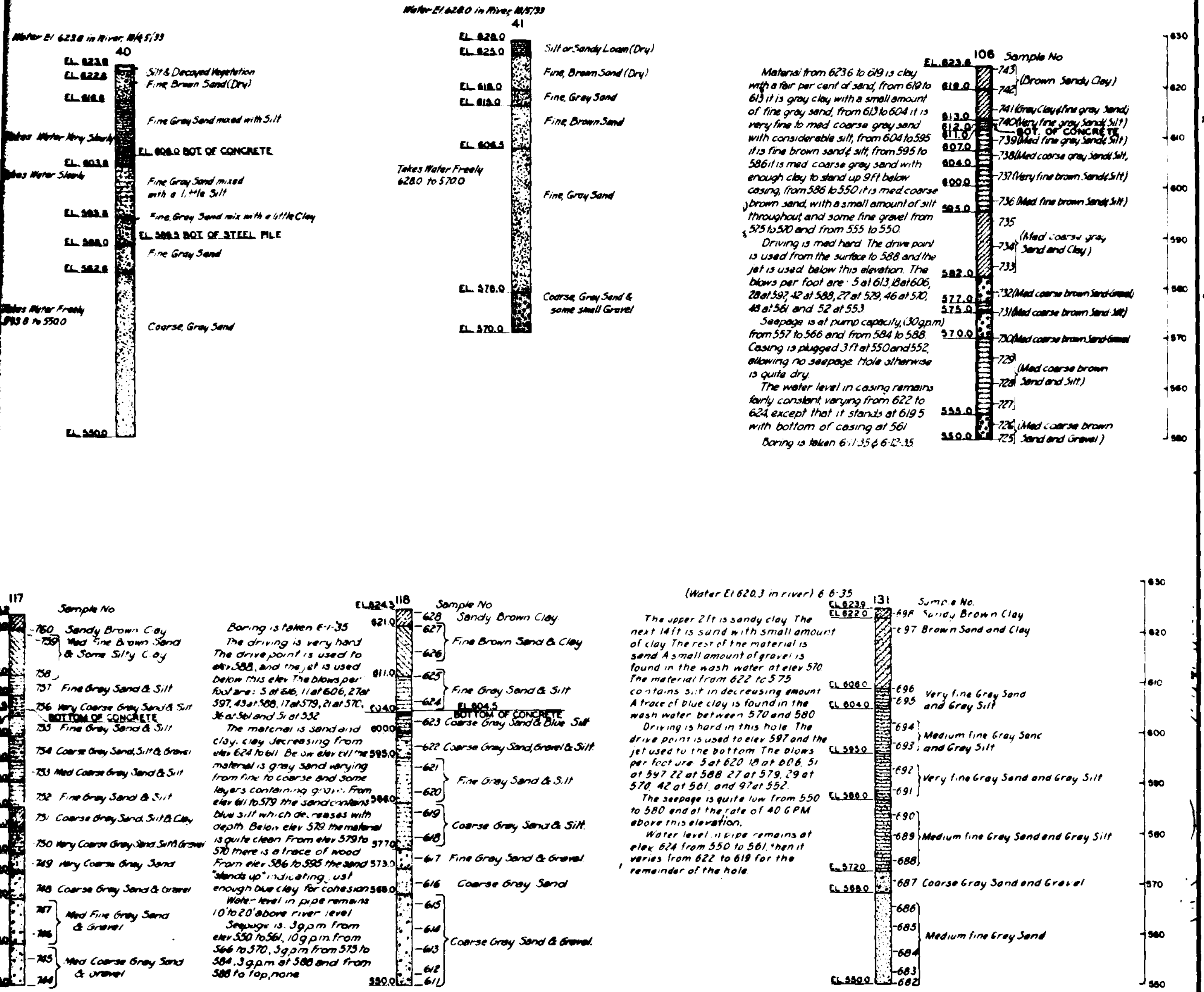
PLATE 2

2



MINNESOTA
MON NO. 2
RIVER
CURRENT
SERVICE BRIDGE
MON NO. 1 (Destroyed)
WISCONSIN
MISSISSIPPI
108
41
40
131
118
117
116
Water El 623.8 in River, 10/15/33
40
EL 623.8
EL 622.8
EL 616.8
EL 608.0 BOT. OF CONCRETE
EL 603.8
EL 593.8
EL 588.5 BOT. OF STEEL PILE
EL 588.0
EL 582.8
EL 550.0
Silt & Decayed Vegetation
Fine Brown Sand (Dry)
Fine Gray Sand mixed with Silt
Takes Water Very Slowly
Takes Water Slowly
Fine Gray Sand mixed with a little Silt
Fine Gray Sand mix with a little Clay
Fine Gray Sand
Takes Water Freely 593.8 to 550.0
Coarse Gray Sand
630
620
610
600
590
580
570
560
550
Water El 623.78 in river 5-21-35
116
Sample No
Water
The drive point is used to elev 564 where driving becomes so hard that the jet is used With the exception of samples 518-520. Samples are taken as the casing is pulled. The driving is increasingly hard from elev 600 to 564 and very hard the remainder. Samples 524-528 contain a blue silt. At elev 586 a trace of wood and clam shells is found. Wash water contains gravel at elev 555-550
A seepage of 40 g.p.m. is found from elev. 600 to 595 and gradually decreasing to 5 g.p.m. at elev 582. The remainder is relatively dry.
The stand of water in the casing is at river level down to elev 595 and 2.0' above the river level below that point
622.0
621.0
609.0
602.0
597.3
593.0
588.3
579.0
575.0
566.3
553.0
550.0
EL 604.5
BOTTOM OF CONCRETE
531 Brown Clay & Sand
530 Brown Sand, Gravel & Clay
529 Coarse Sand, Clay & Mud
528 Med Fine Grey Sand
527 Very Coarse Sand & Fine Gravel
526 Fine Grey Sand
525, 524 Coarse Grey Sand
523 Med Fine Grey Sand
522, 521 Coarse Grey Sand
520, 519, 518 Med Fine Grey Sand
517 Coarse Grey Sand & Gravel
117
EL 623.2
Sample No
Boring is taken 6-12-35 & 6-13-35
Material is all sand except for a shallow layer of clay on top The material varies fine to very coarse. Some gravel is found from 550 to 558, 567 to 572, 576 to 581 and 594 to 597, but in small amount Some silt is found from 623 to 576 in decreasing amounts. At 581 to 585 there is enough clay to stand 2 ft below casing. From 611 to 623 the material contains enough silt and clay to stand up At 583 some decayed wood is found in the wash water
Driving is medium, the drive point is used to elev 583 and the jet is used below that point Hammer blows per foot are: 22 at 605, 29 at 596, 36 at 587, 34 at 578, 39 at 569, 44 at 560 and 39 at 550.
Seepage is quite heavy throughout. Water level in pipe remains close to river level
Casing breaks at elev 574. Pipe redriven to elev 578 27 ft. of 2 inch casing is lost.
620.0
611.0
607.0
EL 604.5
603.0
599.0
594.0
590.0
585.0
581.3
578.0
572.0
567.0
558.0
550.0
BOTTOM OF CONCRETE
760 Sandy Brown Clay
759, 758 Med Fine Brown Sand & Some Silty Clay
757 Fine Grey Sand & Silt
756 Very Coarse Grey Sand & Silt
755 Fine Grey Sand & Silt
754 Coarse Grey Sand, Silt & Gravel
753 Med. Coarse Grey Sand & Silt
752 Fine Grey Sand & Silt
751 Coarse Grey Sand, Silt & Clay
750 Very Coarse Grey Sand, Silt & Gravel
749 Very Coarse Grey Sand
748 Coarse Grey Sand & Gravel
747, 746 Med Fine Grey Sand & Gravel.
745, 744 Med Coarse Grey Sand & Gravel.

1



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY T.M.
DRAWN BY J.I.V.L.
CHECKED BY
SUBMITTED BY
APPROVED

MISSISSIPPI RIVER
LOCK & DAM NO. 8
BORING LOGS AND LOCATION
HYDROPOWER RECONNAISSANCE STUDY

DATE AUGUST 1981
AS SCALE
DRAWING NUMBER
SHEET OF

PLATE 3

APPENDIX A

CONSTRUCTION COST ESTIMATE

TABLE OF CONTENTS

TABLES

APPENDIX A

CONSTRUCTION COST ESTIMATE

BASIS FOR COST ESTIMATES

The Guide Manual: Feasibility Studies for Small Scale Hydropower Additions; U.S. Army Corps of Engineers (HEC) (IWR) July 1979, was utilized to provide a basis for estimating the major share of construction costs that are governed by capacity and head. Costs for turbines and generators were based on a 25 September 1981 quote from Allis-Chalmers. Other site-specific costs were generated from calculated quantities and unit costs. A contingency factor of 15 percent has been used to allow for uncertainties and minor omissions. All costs reflect September 1981 price levels.

Cost estimates - lock and dam 8 hydropower

Item	Estimated quantity	Unit	Unit price	Estimated amount
Tube turbines	-	LS	-	$13,156,000
Powerhouse civil costs	-	LS	-	3,276,000
Station electrical equipment	-	LS	-	1,092,000
Miscellaneous power plant equipment	-	LS	-	280,800
Switchyard civil costs	-	LS	-	41,000
Switchyard equipment costs	-	LS	-	198,900
Transmission line costs	-	LS	-	-
Site specific				
Dewatering	-	LS	-	211,000
Cofferdam fill	14,500	CY	$4.00	58,000
Sheet piling (cells)	60,000	SF	16.00	960,000
Cell fill	9,000	CY	3.00	27,000
Excavation	69,000	CY	5.00	345,000

Cost estimates - lock and dam 8 hydropower (cont)				
Item	Estimated quantity	Unit	Unit price	Estimated amount
Site specific (cont)				
Backfill	2,900	CY	$4.00	$11,600
Riprap	14,200	CY	25.00	355,000
Bedding material	7,180	CY	15.00	107,700
Sandfill	13,000	CY	4.00	52,000
Downstream wing walls	700	CY	180.00	126,000
Grubbing and clearing	-	LS	-	2,000
Concrete channel	1,056	CY	200.00	211,200
Concrete removal	320	CY	50.00	16,000
Powerhouse reinforcing	-	LS	-	328,000
Levee road and parking lot	-	LS	-	78,700
Vehicle bridges	-	LS	-	364,000
Foundation piles	5,100	VLF	8.00	40,800
Storage yard civil work	-	LS	-	218,000
Subtotal				21,556,700
Contingencies (15 percent)				3,233,500
Subtotal				24,790,200
Engineering and design (3 percent)				743,700
Supervision and administration (3 percent)				743,700
Project cost				26,277,600
			Use	26,280,000

ESTIMATE OF ANNUAL CHARGES

Annual charges for the proposed development are based on an interest rate of 7 3/8 percent and an economic life of 100 years.

Estimate of annual charges ($1,000)	
Item	10-unit alternative
Construction first cost	26,280
Present value of replacement costs[1]	95
Interest during construction[2]	1,828
Present value of salvage[3]	-29
Federal investment	28,174
Interest and amortization of Federal investment[4]	2,080
Annual operation and maintenance[5]	106
Total annual charges	2,186

(1) Considers major rehabilitation of operating machinery 50 years after construction.
(2) Assumes 2-year construction period.
(3) Considers salvageable items after rehabilitation 50 years hence, and end of project economic life 100 years hence.
(4) 100-year economic life at 7 3/8 percent interest rate.
(5) Includes winter operation costs.

APPENDIX B

COORDINATION

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APPENDIX B

COORDINATION

This appendix presents the views and comments of other Federal agencies and non-Federal interests with reference to considered hydropower development at lock and dam 8.

DAIRYLAND POWER COOPERATIVE

La Crosse, Wisconsin

54601

March 5, 1980

District Engineer
St Paul District Corps of Engineers
Attn: Planning Branch
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Sir:

A notice issued by the St. Paul District Corps of Engineers dated February 27, 1980, indicates that a reconnaissance study to determine the hydro power potential at Lock & Dam 7 near La Crosse will be initiated.

Dairyland has recently completed an appraisal study of the hydro-electric potential at Lock & Dam 8 near Genoa, Wisconsin. This appraisal study was prepared by Mr. James Calvert of Commonwealth Associates with the economic analysis prepared by Dairyland personnel. The results of this appraisal study indicates that hydroelectric development at Lock & Dam 8 may be feasible from a technical, environmental and economic standpoint.

This study was presented to the Dairyland Board of Directors last week. The Board indicated that it would be desirable to pursue hydroelectric development at Lock & Dam 8. It is our opinion that due to the scope of such a project, the required coordinated operation of a hydroelectric facility with Mississippi River Navigation and present Corps of Engineers ownership of the existing Dams, that it may be appropriate for the Corps of Engineers to develop and operate hydroelectric facilities at the existing navigation dams with Dairyland purchasing the energy output from these Corps owned facilities.

Enclosed for your information is a copy of the Appraisal Study, along with testimony I presented to the Wisconsin Public Service Commission that deals with the economics of hydroelectric development at Lock & Dam 8.

We wholeheartedly support your study of hydroelectric development at navigation dams on the Mississippi River. It is our opinion that Lock & Dam 8 may be a better site to study feasibility. However, we wish to offer our full cooperation and assistance in any manner possible, irregardless of which site you select for study. We would be most happy to meet with you at any time and provide any information that we have as you prepare your studies.

Very truly yours,
DAIRYLAND POWER COOPERATIVE

Jack Leifer, Assistant General Manager

JL:rb
cc: F. Linder
J. Adducci

DIRECT TESTIMONY OF JOHN P. LEIFER
ON HYDRO DEVELOPMENT AT
U.S. ARMY CORPS OF ENGINEERS
LOCK & DAM NO. 8, GENOA, WISCONSIN
AND ON ECONOMIC ANALYSIS OF WIND ELECTRIC SYSTEMS

PLEASE STATE YOUR NAME AND ADDRESS AND SUMMARIZE YOUR EDUCATIONAL, PROFESSIONAL QUALIFICATIONS.

My name is John P. (Jack) Leifer and I am Assistant General Manager, System Engineering Group, Dairyland Power Cooperative, 2615 East Avenue South, La Crosse, Wisconsin. I have previously presented my qualifications in this proceeding.

PLEASE DESCRIBE THE PURPOSE OF YOUR TESTIMONY.

The purpose of my testimony is to discuss in general Dairyland's investigations into the development of low head hydro electric generating facilities to meet future energy requirements. More specifically I would like to discuss the purpose, method, economic evaluation and conclusions of a study performed by Dairyland which was intended to determine the technical feasibility and economic desirability of constructing and operating a hydroelectric generating facility at the Corps of Engineers Lock & Dam facility at Genoa, Wisconsin, referred to as Lock & Dam No. 8. I will be assisted in this effort by Mr. James Calvert, a hydroelectric consultant retained by Dairyland to assist in this study. Mr. Calvert performed a feasibility study of hydro development at Lock & Dam No. 8. His complete report is attached to this testimony as Exhibit (JPL-1), and Mr. Calvert's education and professional qualifications may be found in that report.

A further purpose of my testimony is to present an economic analysis of the installation of large scale wind energy conversion systems on the Dairyland system. This analysis is formulated in conjunction with the analysis performed by Eric [illegible] described in his testimony.

MR LEIFER, WHAT WAS DAIRYLAND'S PURPOSE IN UNDERTAKING THIS HYDRO STUDY?

As is the case with all organizations involved in the production of electric energy, Dairyland has experienced significant increases in the cost of fossil fuel over the last few years. In addition, because of inflation and increasingly stringent pollution abatement regulations, we have experienced sharp increases in the capital costs associated with the installation of new capacity. In the face of these rising costs the economic feasibility of hydroelectric generation has come under renewed scrutiny. As part of our ongoing effort to meet the demand and energy requirements of our member distribution cooperatives at the lowest practical cost, we though it appropriate for Dairyland to evaluate the potential and feasibility of adding hydro capacity to the Dairyland system. One of our first efforts was to make an inventory of existing dams in the Wisconsin service area where there had previously been generators installed, but these generators had been removed. The results of this inventory is shown as Exhibit (JPL-2). As can be seen from inspection of Exhibit there are about 25 existing dams in the Wisconsin service area which previously

had generation installed. Most of these dams are owned by either NSP, Lake Superior District Power Company, Northwest Wisconsin Electric Company or Wisconsin Power & Light. None of these dams are owned by Dairyland.

It is also interesting to note that the total generation that was installed at these sites was approximately 7,000 kilowatts, with an average generation per site of approximately 282 kilowatts. Given the small amount of hydro potential at these existing sites, as well as the great number of sites that would have to be studied, it did not appear to be economically feasible to pursue studies relating to the economic and technical feasibility of adding generators to these existing dams. Another consideration was the expensive and time consuming process of obtaining a license for these hydro facilities from the Federal Energy Regulatory Commission. Therefore we have not pursued at this point the necessary details to develop small hydro sites shown on Exhibit .

Given the fact that the Dairyland service area is in effect bisected by the Mississippi River, which includes a series of navigation and flood control dams that are presently owned by the Corps of Engineers, it seemed logical to pursue the feasibility of installing low head generating equipment at these existing navigation dams. Our Engineering staff has worked with the Corps of Engineers, and from data received from the Corps on river flow and pool elevation, our Engineering staff has calculated that the potential hydro capacity at each Mississippi Lock & Dam in the DPC service area. This initial calculation of capacity was based on a five year average for the years 1974 through 1978, and did not allow for water bypassing turbines during spillage and lock operations.

We have included in this testimony Exhibit (JPL-3), which is a summary of our calculation of the potential hydro capacity at the Mississippi Lock & Dams in the Dairyland service area. Also included is a summary of the Corps of Engineers calculated potential for the same sites. You will note that these calculations are in pretty general agreement. Based on this calculation it appears that there is approximately 90 megawatts potential hydro on the 9 navigation dams on the Mississippi River throughout the Dairyland service area.

WHY WAS LOCK & DAM NO. 8 SELECTED FOR A DETAILED STUDY?

After evaluating the hydro potential at each of the navigation dams located in the Dairyland service area, it was necessary to develop an analysis of environmental, technical and economic feasibility, to determine if more detailed studies were justified. Our approach to the study of the hydro additions to the navigation dams was to select a dam which appeared on the face to be the best candidate for economic development and integration into the Dairyland system. If what appears to be the best potential site is not, after detailed study, proved to be a good candidate for hydro development, we would be very hesitant to spend money for studying other sites. If, on the other hand, what appears to be the best potential site does prove to be a good candidate, then we can proceed with investigations into the development of other sites along the dam system. Lock and Dam No. 8 was selected because the head and river flow data indicated that this dam had the maximum potential for development. Further, the Lock & Dam No. 8 near Genoa is located adjacent to the existing Dairyland Power Plant at Genoa, and also is readily accessible to the Dairyland transmission system.

[illegible] IN THE STUDY?

To more fully analyze the hydro potential at Lock & Dam No. 8, Dairyland retained Mr. James Calvert of Commonwealth Associates, who is a reputable and well known hydroelectric engineer, to conduct a more detailed appraisal study which would develop in greater detail the hydro power potential and also the estimated cost for development of low head hydro at Lock & Dam No. 8. As part of this appraisal Mr. Calvert also investigated the major environmental problems that may be associated with such development. The approach taken in this segment of the study and the results of Mr. Calvert's evaluation are fully detailed in the attached report, Exhibit (JPL-1). In general the report concludes that there does not appear to be any severe environmental problems associated with this project development; secondly, the project appears to be technically and environmentally feasible, and Mr. Calvert recommends a number of steps that should be taken which will determine the ultimate feasibility of the project. These steps are summarized as follows:

1) Establish the firm level of capacity as related to system or pool requirements.

2) Perform an economic evaluation of the power potential considering the long life of hydro, low operating cost, and future escalation of alternative fossil fuels.

3) Determine the preliminary attitude of the Corps of Engineers, U.S. Fish & Wildlife Service, and other concerned agencies to the proposed project, and tentative method of development.

4) Seek a preliminary permit from the Federal Energy Regulatory Agency to perform detailed studies and prepare a license application.

5) Undertake a feasibility investigation, possibly with financial help from the Department of Energy under their Small Hydro Assistance Program.

6) Design and construct the project.

The appraisal also indicates that a hydro plant of 10,000 KW nameplate rating can be installed on Lock & Dam No. 8, and that in an average year could deliver to the Dairyland system about 52 million kilowatt hours of renewable energy. Although the plant would experience reduced or [illegible] capacity for extended flood periods due to insufficient head, it was determined that at least 7,000 KW would be available for 90% of the time during an average winter period of November through February. This period is Dairyland's winter peak load and therefore we are of the opinion that the 7,000 kilowatts would be considered firm capacity. To put the output of this hydro facility in perspective the 52 million kilowatt hours of energy it would produce annually is 1.8% of Dairyland's total requirements in 1978. The 7 megawatt output is about 1.2% of Dairyland's peak load in 1978. By 1987 the output of this plant would provide less than 1% of both Dairyland's energy and capacity needs. It also should be noted that the calculated hydro potential at Lock & Dam by both Dairyland and the Corps of Engineers was approximately 14 megawatts. Based upon the assessment prepared by Mr. Calvert, the maximum unit that could be accomodated is 10 MW with a firm capacity of approximately 7 MW. Therefore it is safe to say that the balance of the dams on the Mississippi that were analyzed in all likelihood would have lower firm capacity than are listed on Exhibit (JPL-3). In fact, a column has been added to Exhibit (JPL-3) which is Mr. Calvert's assessment of other Lock & Dams in the Mississippi which flows through the Dairyland service area. As can be seen, the maximum potential is somewhat less than the calculated potential of both Dairyland and the Corps of Engineers. This indicates that the feasibility of each individual Lock & Dam must be analyzed in order to determine its feasibility. However, based upon the appraisal study thus far it would appear that Lock & Dam 8 is the most likely candidate to prove economic and technical feasibility for hydroelectric development.

WHAT WAS THE NEXT STEP PERFORMED IN YOUR STUDY?

Upon completion of the appraisal study of Lock & Dam No. 8, Dairyland made a detailed economic analysis of the project. This included taking the estimated construction costs as determined in Mr. Calvert's appraisal, which included all construction costs except for the transmission substations, administrative and general expenses, and interest during construction. Dairyland has made estimates for these costs and have developed a total cost of the project in January 1, 1980 dollars. This summary of costs is shown as Exhibit (JPL-4). The total cost for the project in January 1st 1980 dollars is $22,410,000.

It has been estimated by Mr. Calvert that this project could be completed in approximately three and a half years. Therefore we estimated the costs of the project in terms of a completion date of June 30, 1983. We have assumed that capital costs will escalate at 7% per year, and that Dairyland's interest during construction is based upon a 7½% interest rate.

We also made an analysis of the possibility of this unit being delayed due to long lead times for permit approval, environmental impact statements and other regulatory problems. This analysis assumed that the project would go in service on November 1st, 1987, which is the same date that we are proposing Project 87 to go in service. This analysis, with the November 1987 completion date, will allow a direct comparison of the power costs from this hydro project with Project 87 costs.

A summary of the estimated costs for completion in 1983 and 1987 is included in Exhibit (JPL-4). Other costs that have been included in our economic analysis are annual operating and maintenance costs and annual insurance costs. We have used the estimated costs for annual operating and maintenance costs that were developed in Mr. Calvert's appraisal. Our annual insurance costs have been developed based upon similar costs that we experienced in our Flambeau Hydro Station.

In determining the fixed charge rate we include the cost of money and also the impact of the property tax upon a project. The assumptions as to interest rates, annual escalation, interest during construction, property taxes, that were included in the economic analysis, are included as Exhibit (JPL-5).

WHAT WERE THE RESULTS OF THE ECONOMIC ANALYSIS?

The results of the economic analysis are summarized in Exhibit (JPL-6). The results of this analysis indicate that with an interest rate of 9% and a facility life of 50 years, and property taxes based on the present rates in Minnesota, that this project would have a levelized cost of 6.9999¢ per kilowatt hour if it was constructed and completed by 1983. If the project is completed by November 1987 the annual levelized cost of the project would be 9.15¢ per kilowatt hour. This compares to the annual levelized cost of Project 87 of 7.15 ¢ per kilowatt hour.

DID YOU PERFORM ANY ANALYSIS TO CHECK THE SENSITIVITY OF YOUR ECONOMIC EVALUATION TO VARIATIONS IN YOUR ASSUMPTIONS?

Yes. A second economic analysis has been made which was based on several assumptions as to financing costs and tax credits. From our analysis of the incentives being offered by federal and state government for the development of hydro projects indicates that these incentives are in the reduction in interest rates for capital expenditures as well as tax credits. We have talked to several financial institutions about how these tax credits might affect Dairyland. It appears from current pending legislation in the United States Senate that industrial development bonds could be used to finance hydroelectric development. These industrial revenue bonds are bonds floated by municipals and other governmental bodies which are exempt from federal income tax. It would appear from our discussions with financial institutions that these bonds could carry an interest rate of several percentage points lower than Dairyland's present financing methods. Therefore we have assumed in our sensitivity analysis that an interest rate of 7% for development of the Genoa hydro project would be a reasonable rate to look at.

We have also assumed in the sensitivity analysis that the State of Minnesota would not tax the project with a property tax, and therefore would reduce the property tax to zero. These assumptions are speculative at this particular point. However, they do offer some sensitivity as to the incentives that could be offered by federal and state governments.

Based on the annual cost analysis included as Exhibit (JPL-7) it is indicated that with these reduced interest rates and no property tax that the annual levelized cost with the unit constructed and in service by 1983 would be 4.61¢ per kilowatt hour, and with the unit in service in November 1987 the levelized annual cost per kilowatt hour would be 6.03¢ per kilowatt hour. This compares to a levelized cost of 7.15 ¢ per kilowatt hour from Project 87.

IN PERFORMING YOUR STUDY HAVE YOU CONSIDERED THE POSSIBILITY OF RECEIVING GOVERNMENT FINANCIAL SUPPORT FOR THE DEVELOPMENT OF HYDRO CAPACITY?

Yes. In our answer in the previous question we have investigated the reduction in the interest rate of approximately 2%, and also have looked at a reduction or a cancellation in property taxes. The legislation currently pending in United States Senate would provide that interest on industrial development bonds issued to finance facilities the primary function of which is the generation of hydro electric power, is exempt from federal income taxation. If the bill were passed in the present form, the availability of industrial development bond financing for hydroelectric facilities in Wisconsin, Minnesota, Iowa and Illinois, would depend upon whether industrial development bond statutes of those states permit the financing of such facilities. The Wisconsin and Minnesota Statutes appear to be sufficiently broad to permit such a financing . However, legislation may be required for Dairyland to use industrial development bond financing for hydroelectric facilities in Iowa and Illinois.

As indicated in our previous discussion, this industrial development financing would allow the cost of money approximately 2 percentage points below present Dairyland financing sources. The proposed Genoe hydro development is located in the State of Minnesota. There is no indication that the State of Minnesota would not charge a property tax on the proposed development. However, it is felt that perhaps this kind of incentive could be offered by the legislature should development of the hydro potential at the Lock & Dam system become a reality. If we would embark upon this project we would investigate all possible sources of financing that may be available to these types of projects.

WHAT OBSTACLES DO YOU FORESEE TO THE PURSUIT OF HYDROELECTRIC DEVELOPMENT?

At the present time we see the licensing procedure of the Federal Energy REgulatory Agency to be a major obstacle to this or any hydro project. We also must investigate more closely the environmental effects of this project, particularly on the attitudes of the Corps of Engineers, U.S. Fish & Wildlife Service and other concerned agencies on the specific project. As the project is proposed, the power house will be located very close to the Fish & Wildlife Refuge, and there is concern that during construction we would need considerable amount of Refuge property for such things as material laydown, a cement batch plant, and other types of construction activity. We also would be required to move in and out of the site by way of the dike that extends from the end of the existing dam to the Minnesota side, and we understand that there are several nesting habitats of bald eagles in that particular region. Therefore, the attitude of the Fish & Wildlife Service is not completely understood at this particular time.

We also must study the effects upon the sport fishing in the Mississippi River below the dams, and the operation of the Lock & Dam system is primarily for navigation, with some flood control, we must investigate further with the Corps of Engineers their operating philosophy to determine if this operating philosophy would blend with the successful operation of a hydro project.

Another concern that would appear to be an obstacle is the small size of the project, and the relatively high cost. We have not investigated all the costs of the regulatory procedure to obtain approval of this particular project, but it would appear that these costs could be substantial, and without further investigation into these particular costs we don't know if the frontend cost of obtaining regulatory approval are worth the effort for such a small amount of installed generating capability.

DIRECTING YOUR ATTENTION TO A DIFFERENT TECHNOLOGICAL AREA, MR. LEIFER, WHAT SORT OF ECONOMIC ANALYSIS HAVE YOU PERFORMED IN CONJUNCTION WITH MR. HENNEN'S WIND ENERGY CONVERSION SYSTEM STUDIES?

An economic analysis has been made of various wind energy conversion systems (WECS). Mr. Hennen has made an estimate of the capital cost for constructing various types of WECS in either 100 unit arrays, or the same units constructed on a diversified basis throughout the Dairyland system. We have studied in detail two types of units, the WTG Unit, which is a 200 kilowatt rated unit, and the Alcoa Vertical Axis Unit, which is a 300 kilowatt rated unit.

Mr. Hennen in his testimony has discussed the energy output of each of these types of machines. Additionally we have looked at the MOD-2 Unit on an individual basis. Our estimates for these costs are very preliminary based on manufacturers data only and no experience. Mr. Hennen has discussed the MOD-2 Unit in his testimony.

Our evaluation assumed that the units would be installed either on 7-1-1983, or 11-1-1987. This was done for comparison purposes with the installation dates of other units considered in our studies. We have calculated the interest during construction and inflation to determine the investment cost required on those in-service dates. Exhibit (JPL-8) is a summary of the estimated construction cost of the various units analyzed.

Additionally we made an analysis of the Alcoa Units with the electrical generator and equipment price reduced by 50%. This was done to test the sensitivity of the economics should costs decline due to increased production of these generator units. These costs include the wind generator and supporting structures for the wind generating equipment.

As indicated, we have evaluated the units in either a 100 unit array, which would mean that the units would be installed in an array on a common site, each separated by ten blade diameters or blade heights, depending upon the type of unit. This installation would have advantages for operation and maintenance of a WECS system.

We have also evaluated the impact of taking the same 100 units of either the WTG or Alcoa type and installing them at dispersed locations throughout the Dairyland system. The detailed advantages of this type of installation will be presented by Mr. Hennen.

Based on the estimated construction costs shown in Exhibit (JPL-8) as well as the estimated operation and maintenance costs shown in Exhibit (JPL-9), we have determined the levelized annual cost of energy from each of the systems studied. The annual cost analysis to determine the levelized cost of energy from the WECS system was based on a facility life of 35 years, which hasn't been proven for wind machines.

Also included in the analysis for both the WTG 100 unit array, and the Alcoa 100 unit array, is a land revenue credit. There are wide areas of land available between each windmill in the array that could be grazed or planted. ... termined that this land could be rented for agricultural purposes and therefore the revenue from this rental is applied as a credit to the annual costs of these plans.

WHAT WERE THE RESULTS OF THESE ANALYSES?

The economic analysis of the WECS systems studied indicate that the levelized annual cost in cents per kilowatt hour range from 9.6¢ per kilowatt hour to 17.4¢ per kilowatt hour for systems installed in 1983. The system installed in 1987 would have similar costs ranging from 12.8¢ per kilowatt hour to 23¢ per kilowatt hour. A summary of the levelized annual cost in cents per kilowatt hour is included as Exhibit (JPL-10).

DID YOU PERFORM ANY SENSITIVITY ANALYSIS IN CONJUNCTION WITH YOUR ECONOMIC ANALYSIS?

Yes, we have analyzed the sensitivity of our original analysis.

For study purposes we reduced the Alcoa generator costs, which includes the wind generator and all supporting structures, by 50%, to determine the effect upon the annual costs of the economies that could be gained by mass producing wind generating equipment. We selected the Alcoa Unit because it appeared to be the lowest cost unit compared to the WTG units. This sensitivity analysis is shown on Exhibit (JPL-10). With the present Dairyland financing and present property tax rates the levelized annual cost of energy from these units range from about 12¢ per kilowatt hour for units installed in 1983, to around 15¢ to 17¢ per kilowatt hour if a unit is installed in 1987.

Additionally we made an analysis assuming that construction of these WECS systems could be financed using industrial development bond financing which has a interest rate approximately 2% lower than Dairyland's conventional source of financing, and also that the State of Wisconsin would not tax these systems and therefore subsidize them to some extent. Using these reduced interest rates and property taxes, we have calculated the levelized annual cost in cents per kilowatt hour for units installed in 1983 and in 1987. These costs range from 7.4¢ per kilowatt hour to 13.8¢ per kilowatt hour for 1983 investments, or with units installed in 1987 the annual levelized cost would range from 10.1¢ to 18.4¢ per kilowatt hour. A summary of the levelized annual cost with the industrial development bond financing and property tax relief, is included in EXhibit (JPL-10).

WHAT HAVE YOU CONCLUDED AS A RESULT OF THIS WECS ANALYSIS?

Based upon the results of this analysis of the WECS system it would appear that the costs of WECS systems, particularly the smaller 100 and 300 kilowatt units, are not economically comparable to fuel prices from conventional fossil units. WE prepared a levelized cost of fuel analysis for Project 87, which indicates over the 35 year life of Project 87, that the levelized fuel cost would be about 4.7¢ per kilowatt hour, with fuel escalation at 7% per year.

With fuel escalation of 10% per year, a levelized fuel cost for the 35 year period of 7.6¢ per kilowatt hour would result.

Due to the vagaries of the wind WECS can be counted upon only as fuel savers and not as firm capacity for utilities. Therefore, it is proper to compare the annual costs of a wind system to the annual costs of a fuel which it will replace. As the Dairyland system produces most of its energy with coal-fired steam generating equipment, it would be proper to compare the fuel costs from these steam units to the levelized annual cost of the WECS systems.

Based upon our analysis it would appear that the larger MOD-2 WECS may be economically justifiable as a fuel saver in the future. The smaller 200 and 300 kW units do not appear at this time to be economically comparable to the fuel cost from fossil units. It would appear that Dairyland should continue to monitor the development of the MOD-2 WECS
It should be pointed out that the MOD-2 has not been built and the costs used in this analysis are costs based on estimates developed in 1977. The first installation of the MOD-2 program is a cluster of units to be installed by the Bonneville Power Authority in late 1980, or early 1981. The research and development of the WECS is rapidly getting under way, Dairyland is committed to monitoring these programs to determine their applicability to the Dairyland system.

DOES THAT CONCLUDE YOUR TESTIMONY?

Yes.

TABLE JPL-2

EXHIBIT

DAIRYLAND POWER COOPERATIVE
EXISTING DAMS WITH GENERATION REMOVED
IN WISCONSIN SERVICE AREA

County	Site	River	Owner	Generator Rating KW*
Crawford	Gays Mills	Kickapoo	WP&L	264
Richland	Muscoda	Mill Creek	Muni	145
Sauk	La Valle	Baraboo	Muni	125
Juneau	Mauston	Lemonweir	WP&L	360
Juneau	Necedah	Yellow	WP&L	260
Monroe	Angelo	La Crosse	NSP	150
La Crosse	West Salem	La Crosse	NSP	125
Dunn	Elk Creek	Elk Creek	DPC	125
Dunn	Eau Galle	Eau Galle	NSP	360
Dunn	Colfax	Red Cedar	NSP	1200
St. Croix	Hudson	Willow	NSP	300
St. Croix	Little Falls	Willow	NSP	300
St. Croix	Willow Falls	Willow	NSP	600
St. Croix	Mounds	Willow	NSP	180
St. Croix	McClure	Apple	NSP	160
St. Croix	Huntington	Apple	NSP	640
Polk	Little Falls	Apple	NSP	92
Polk	Country Day	Apple	NWWE	50
Polk	Balsam Lake	Balsam Brook	NWWE	68
Barron	Chetek	Chetek	NSP	250
Barron	Red Lake	Red Cedar	NSP	320
Chippewa	Tildem	Duncan Creek	Private	93
Pirce	Pixley Rapids	Flambeau	LSDP	347
Ashland	Mellon	Bad	LSDP	450
Bayfield	Iron River	Iron	LSDP	96
Total Generation				7,060 kW
Average Generation per site.				282.4 kW

*Rating when generators were in service.

EXHIBIT

DAIRYLAND POWER COOPERATIVE
MISSISSIPPI RIVER HYDRO POTENTIAL

Location	Dam No.	DPC[(a)] MW	C. of E.[(b)] MW	CAI[(c)] MW
Red Wing	3	5.1	4.8	
Alma	4	9.6	8.8	5.3
Fountain City	5	13.7	14.0	7.0
Winona	5A	6.6	6.6	
Trempealeau	6	6.1	7.4	6.6
Dresbach	7	10.4	12.6	
Genoa	8	14.7	14.0	10.0
Lynxville	9	9.6	9.6	8.7
Guttenberg	10	12.2	13.6	8.0
Total		88.0	91.4	

(a) Hydro Potential calculated by DPC based upon average head and flow data for the 5 year period 1974-1978.

(b) Corps of Engineers Hydro Potential.

(c) Commonwealth Associates Hydro Potential based upon the results of the Genoa Hydro Appraisal Study.

TABLE JPL-4

EXHIBIT

DAIRYLAND POWER COOPERATIVE
ESTIMATED CONSTRUCTION COSTS
GENOA HYDRO PROJECT
1/1/80 - $1000

	Est. Cost $1000
DIRECT COSTS	
Land & Land Rights	150
Power Plant Structures	3,705
Reservoir, Dams & Waterways	1,849
Turbines & Generators	10,945
Accessory Elect. Equip.	946
Misc. Power Plant Equip	307
Roads	8
Transmission Station Equip	700
Total Direct Costs	18,610
INDIRECT COSTS	
Temp. Const. Facilities	300
Environmental Control	250
Misc. Indirect Const.	1,100
Total Indirect Costs	1,650
OVERHEAD COSTS	
Engineering	1,800
Legal Expenses	100
Administrative & General	250
Total Overhead Costs	2,150
TOTAL PROJECT COST 1/1/80	$22,410

ESTIMATED COST	Completion 7/1/83		Completion 11/1/87	
	$1000	$/kW	$1000	$/kW
Project Cost	$22,410	$3,201	$22,410	$3,201
Int. during construction	3,314	473	5,782	826
Escalation	4,659	666	11,624	1,660
Total Cost	$30,383	$4,340	$39,816	$5,688

EXHIBIT

ECONOMIC ANALYSIS
STUDY ASSUMPTIONS

Interest	
REA guaranteed loan funds	9%
Industrial development	7%
Interest during construction	7.5%
Annual Escalation per year	
Investment	7%
Operating Costs	7%
Insurance Costs	4%
Property Taxes	
Wisconsin	1.8%
Minnesota	2.2%
Facility Life	
Hydro	50 years
Wind	35 years
Fossil	35 years

TABLE JPL-6

ANNUAL COST ANALYSIS
GENOA HYDRO PROJECT

UNIT DATA

Generating Capacity	7,000 kW
Annual Energy	52,000 MWA

ESTIMATED COSTS

	$1000	$/kW
Investment		
1/1/80	22,410	3,201
7/1/83	30,383	4,340
11/1/87	39,816	5,688

ANNUAL OPERATING (7%)

1/1/80	48
7/1/83	63
11/1/87	82

INSURANCE (4%)

1/1/80	12
7/1/83	14
11/1/87	16

ANNUAL REVENUE REQUIREMENTS

Assumptions

Interest Rate	9%
Facility Life	50 years
Salvage Value	0
Taxes	2.2% Minnesota

Fixed Charge Rate (FCR) = CRF + Taxes

CRF = 9% 50 yrs = 9.12%

FCP = 9.12% + 2.2% = 11.32%

LEVELIZED COSTS - $1000

	In Service 7/1/83	In Service 11/1/87
Fixed Cost	$3,440	$4,507
Operating Cost	173	226
Insurance	23	26
Total Annual Cost	3,636	4,759
Annual Cost - c/KWH	6.99	9.15

ANNUAL COST ANALYSIS
GENOA HYDRO PROJECT

UNIT DATA

Generating Capacity	7,000 kW
Annual Energy	52,000 MWA

ESTIMATED COSTS	$1000	$/kW
Investment		
1/1/80	22,410	3,201
7/1/83	30,383	4,340
11/1/87	39,816	5,683
ANNUAL OPERATING (7%)		
1/1/80	48	
7/1/83	63	
11/1/87	82	
INSURANCE (4%)		
1/1/80	12	
7/1/83	14	
11/1/87	16	

ANNUAL REVENUE REQUIREMENTS

Assumptions

Interest Rate	7%
Facility Life	50 years
Salvage Value	0
Taxes	0

Fixed Charge Rate (FCR) = CRF + Taxes

CRF 7% - 50 yrs = 7.25%

FCR 7.25% - 0 = 7.25%

LEVELIZED COSTS - $1000

	In Service 7/1/83	In Service 11/1/87
Fixed Cost	$ 2,203	$ 2,887
Operating Cost	173	226
Insurance	23	26
Total Annual Cost	2,399	3.139
Annual Cost - ¢/KWH	4.61	6.03

TABLE JPL-8

EXHIBIT

WIND ENERGY CONVERSION SYSTEMS
ESTIMATED CONSTRUCTION COST
COSTS IN $1000

System	Construction Cost 1/1/80	Interest During Construction	Inflation	Total Co on In Se Date
UNITS IN SERVICE 7/1/83				
WTG-100 Unit Array	26,724	3,725	5,764	36,213
WTG-100 Unit Diversified	28,934	4,033	6,240	39,207
Alcoa-100 Unit Array	26,965	3,759	5,816	36,540
Alcoa-100 Unit Diversified	24,881	3,468	5,366	33,715
Alcoa-100 Unit Array*	19,465	2,713	4,198	26,376
Alcoa-100 United Diversified*	17,381	2,423	3,748	23,552
MOD-2	3,031	423	645	4,099
UNITS IN SERVICE 11/1/87				
WTG-100 Unit Array	26,724	4,896	16,114	47,734
WTG-100 Unit Diversified	28,934	5,301	17,447	51,682
Alcoa-100 Unit Array	26,965	4,940	16,260	48,165
Alcoa-100 Unit Diversified	24,881	4,558	15,003	44,442
Alcoa-100 Unit Array*	19,465	3,566	11,737	34,768
Alcoa-100 Unit Diversified*	17,381	3,184	10,481	31,046
MOD-2	3,031	555	1,828	5,414

*Cost of wind generating equipment reduced by 50%.

TABLE JPL-9

EXHIBIT

WIND ENERGY CONVERSION SYSTEMS ESTIMATED OPERATING COSTS AND ANNUAL ENERGY OUTPUT

System	Operation Costs 1/1/80	Insurance Costs 1/1/80	Energy Output MWH	Installed Capacity MW
UNITS IN SERVICE 7/1/83				
WTG - 100 Unit Array	540	9	31,000	20
WTG - 100 Unit Diversified	600	9	33,700	20
Alcoa - 100 Unit Array	450	8	31,000	30
Alcoa - 100 Unit Diversified	600	8	33,800	30
MOD-2	91	2	7,689	2.5

EXHIBIT

WIND ENERGY CONVERSION SYSTEMS
SUMMARY OF LEVELIZED ANNUAL COSTS

I. Levelized Cost Assuming Present Financing and Property Tax Rates.

System	Levelized Annual Cost - ¢/KWH: Installation 7/1/83	Levelized Annual Cost - ¢/KWH: Installation 11/1/87
WTG - 100 Unit Array	17.4	23.1
WTG - 100 Unit Diversified	15.4	20.5
Alcoa - 100 Unit Array	16.2	21.4
Alcoa - 100 Unit Diversified	13.9	18.4
Alcoa - 100 Unit Array*	12.6	16.8
Alcoa - 100 Unit Diversified*	11.0	14.7
*Cost of wind generating equipment reduced 50%		
MOD-2	9.6	12.8
Project 87 Fuel Cost - 7% Escalation		4.7
10% Escalation		7.6

II. Levelized Cost Assuming Industrial Development Bond Financing and Property Tax Relief.

System	Levelized Annual Cost - ¢/KWH: Installation 7/1/83	Levelized Annual Cost - ¢/KWH: Installation 11/1/87
WTG - 100 Unit Array	13.8	18.4
WTG - 100 Unit Diversified	12.3	16.4
Alcoa - 100 Unit Array	12.3	16.4
Alcoa - 100 Unit Diversified	11.3	15.0
Alcoa - 100 Unit Array *	9.9	13.3
Alcoa - 100 Unit Diversified*	9.4	12.5
*Cost of wind generating equipment reduced 50%		
MOD-2	7.4	10.1
Project 87 Fuel Cost - 7% Escalation	-	4.7
10% Escalation	-	7.6

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT. CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL. MINNESOTA 55101

REPLY TO
ATTENTION OF:
NCSED-PB

6 July 1981

NOTICE

LOCK AND DAM 8
HYDROPOWER RECONNAISSANCE STUDY

The St. Paul District, Corps of Engineers, has initiated a reconnaissance study to determine the potential for hydropower generation at the existing Corps of Engineers navigation lock and dam 8 on the Mississippi River near Genoa, Wisconsin. The reconnaissance report culminating the study will be completed by September 1981.

The intent of the reconnaissance study is to establish, in a general way, whether hydropower production at lock and dam 8 is economically justified and assess the issues that may be critical to implementation. Existing information will be used to the extent practicable, particularly the appraisal study of lock and dam 8 by Dairyland Power Cooperative. The reconnaissance study will not provide detailed formulation of a plan or optimal scale of development. Rather, the study will show whether at least one plan is workable and feasible. If a plan is found justified, a more detailed feasibility study will be recommended to start in fiscal year 1982 which begins 1 October 1981.

Because the reconnaissance study is preliminary, an intensive public involvement program is not planned. Agencies and interests are being informed of the study at its outset and invited to participate by this mailed notice. News releases to the general public will be prepared, as appropriate. When the reconnaissance study is completed, a public meeting will be held to discuss the report and its findings and help direct feasibility study efforts, if further studies are recommended in the reconnaissance report.

At this time, we request your input and suggestions regarding the study. Your comments can be sent to:

Commander
St. Paul District, Corps of Engineers
ATTN: Planning Branch
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

for
WILLIAM W. BADGER
Colonel, Corps of Engineers
Commander

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Public Notice on Lock and Dam
8 Hydropower Study

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Metropolitan Council Library
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Government Publications Div.
409 Wilson Street
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University of Minnesota
Agricultural Library
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ATTN: Documents Librarian
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STATE INTEREST GROUPS

Sierra Club
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111 Franklin Ave. E
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319 North 4th Street
St. Louis, Missouri 63102

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United States Department of the Interior

IN REPLY REFER TO:

FISH AND WILDLIFE SERVICE
TWIN CITIES AREA OFFICE
530 Federal Building and U.S. Court House
316 North Robert Street
St. Paul, Minnesota 55101

AUG 13 1981

Colonel William W. Badger
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Badger:

This responds to your July 6, 1981, notice requesting our comments on the preparation of reconnaissance studies for hydropower generation at lock and dam 1, 5, and 8 on the Mississippi River in Minnesota and Wisconsin. We offer the following comments to assist you in the preparation of these studies.

<u>Existing Fish and Wildlife Resources</u>

Lock and Dam 1 -- Fish and wildlife populations are somewhat limited in the Minneapolis pools primarily because of the lack of shallow water habitat, the relatively small size of the pools, and industrial development along the riverbanks. Occasional periods of poor water quality further reduce the value of fishery habitat. However, valuable habitat for upland species can be found on the wooded bluffs along Pool 1. Sport fishing is common in the pools despite the relative lack of quality fishery habitat. Firearm restrictions prohibit hunting in the urban areas.

Fishery habitat is limited but generally good in Pool 2 upstream of downtown St. Paul. However, the quality of fishing declines in the lower portions of the Minnesota River and downstream portions of Pool 2 because of poor water quality. Valuable wildlife habitat can be found in the areas of Crosby Lake, Pigs Eye Lake, and Grey Cloud Island and on the Minnesota River within the Minnesota Valley National Wildlife Refuge and Black Dog Lake. Pigs Eye Lake, located in Pool 2 downstream of downtown St. Paul, has a unique heron-egret rookery located at its border. This rookery is maintaining itself and contains black-crowned night herons, great blue herons, and common egrets.

Sport fishing is provided in the tailwater areas of lock and dam 1 and at the outfall of Black Dog Lake. Hunting is prohibited in the majority of Pool 2 and on the Minnesota River within the metropolitan area.

Lock and Dam 5 -- Significant areas in Pools 5 and 5A are managed as wildlife refuges (UMRWLFR, Trempealeau, Wisconsin DNR areas). Pool 5 provides excellent and diverse habitat for both fish and wildlife. The backwaters of the Weaver Bottoms and Belvidere Slough provide excellent spawning, nesting, and rearing areas. A large portion of the Weaver Bottoms is closed to waterfowl hunting and provides an important resting and feeding sanctuary for migrating waterfowl. Pool 5 is also used extensively for public recreation (hunting, fishing, trapping, camping, and boating). Sport and commercial fishing, waterfowl hunting, and trapping are considered excellent in Pool 5.

Pool 5A also provides valuable fish and wildlife habitat. The Fountain City Bay area and the extensive areas between Fountain City Bay, Wisconsin, and Minnesota City, Minnesota, provide exceptional fishing, hunting, and trapping opportunities. A large heron and egret rookery exists in the Fountain City Bay area. In addition, Pool 5A is used heavily for public recreation. One major park -- Merrick State Park in Wisconsin -- is located adjacent to the pool. Several private developments provide additional recreational facilities. In addition, two archeological sites on the Minnesota side of Pool 5A are on the National Register. The Wisconsin Department of Natural Resources (WDNR) has designated one natural area -- Kammeroski Rookery at River Mile 734.

Lock and Dam 8 -- Significant areas in Pools 8 and 9 are also managed as wildlife refuges (UMRWLFR and State refuge areas). Pool 8 provides valuable fish and wildlife habitat and hunting, fishing, and trapping are considered excellent throughout the extensive backwater areas. In addition, backwater areas provide valuable resting and feeding habitat for migrating waterfowl, including canvasback ducks. A heron and egret rookery exists in the delta of the Root River. Pool 8 is also used extensively for public recreation. Two archeological sites have been documented on the pool, one at Goose Island and another along the Wisconsin shore at River Mile 693.5. Wisconsin has designated a natural area, Turtle Nesting Site, at River Mile 685. Most of the pool lies within the La Crosse District of the Upper Mississippi River Wild Life and Fish Refuge.

Pool 9 also provides excellent fish and wildlife habitat. Backwater areas provide valuable resting and feeding habitat for migratory waterfowl

including canvasback ducks. In particular, areas near Lansing, Big Lake, Reno Bottoms, and Winneshiek Slough provide outstanding fish and wildlife habitat. Most of the pool lies within the Lansing District of the Upper Mississippi River Wild Life and Fish Refuge.

Pool 9 is also used extensively for public recreation. Hunting, sport fishing, trapping, and commercial fishing are considered outstanding in the pool. In addition, Pcol 9 contains several cultural, natural, and scientific areas. A number of Indian mound sites are in the area including Waukon Junction, Keller, Capoli Bluff, Hemingway Mound Groups, and the Effigy Mounds National Monument. In addition, the Iowa State Preserve Board owns the Fish Farm Mounds Preserve south of New Albin, Iowa.

Several federally designated endangered or threatened species have been known to occur in these areas of the Upper Mississippi River. The bald eagle (*Haliaeetus leucocephalus*), classified as a threatened species in Minnesota and Wisconsin and endangered in Iowa, winter in numbers on the Upper Mississippi River, concentrating below dams or near the mouths of tributaries where fish provide a ready food supply. Also, the endangered Higgin's eye pearly mussel (*Lampsilis higginsi*) inhabits portions of the river. Historically, the endangered peregrine falcon (*Falco peregrinus*) has also been known to occur in areas along the Upper Mississippi River.

Concerns

Construction and operation of hydropower facilities at the above locations will impact fish and wildlfe resources, the extent of which must eventually be documented should the projects appear feasible. A major concern involves potential effects to existing daily and seasonal water levels. A change in such levels could result in adverse impacts to wetlands, backwater areas, shoreline habitat, and associated fish and wildlife resources and may also conflict with the management of refuge lands. Regardless of a change in water levels, the location of the generating facility and its operation could alter existing flow patterns. Existing flows are fairly uniform across the river at the above locks and dams. Concentrating a portion of this flow through the generating facility could affect existing upstream and downstream flow patterns, terrestrial and aquatic habitats, possibly increase scouring and erosion, and affect the existing tailwater sport fisheries. We would be particularly concerned about this funneling effect during low flow periods.

We are also concerned with potential injury and mortality of aquatic organisms due to entrainment through the generating facilities. Impingement of organisms may also be an important factor if screening devices are used at the intakes. In addition to design, construction, and operation of the generating facility, construction of required transmission lines, corridors, and other facilities could also result in adverse impacts to fish and wildlife resources.

As stated earlier, most lands in the vicinity of lock and dam 5 and 8 are included in the Upper Mississippi River Wild Life and Fish Refuge. From the refuge standpoint, we are concerned that project construction and operation may adversely impact these holdings. Proposals for construction of hydropower facilities at these locations must, therefore, be closely coordinated with the Service.

The above concerns should be adequately addressed in the future studies if the addition of generating facilities appears economically feasible. We also suggest the projects be closely coordinated with the Wisconsin and Minnesota Departments of Natural Resources and Iowa Conservation Commission where appropriate. We appreciate the opportunity to offer our comments on these projects and look forward to our continued coordination on this matter.

Sincerely yours,

James L. Smith
Acting Area Manager

cc: UMRWLFR, Winona, MN
UMRWLFR, LaCrosse, WI
UMRWLFR, Lansing, IA
MN Valley NWR, Bloomington, MN

Wisconsin Power & Light Company

Investor-owned Energy

222 West Washington Avenue   P. O. Box 192   Madison, Wisconsin 53701   Phone 608/252-3311

August 27, 1981

Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, MN 55101

Attention: William W. Badger, Colonel
Corps of Engineers Commander

Re: Hydro Power Reconnaissance Studies

Gentlemen:

We are in receipt of your notices dated 6 July 1981 regarding reconnaissance studies to determine hydro power potential at existing Corps of Engineers lock and dam Nos. 8 at Genoa, Wisconsin, 5 near Fountain City, Minnesota, and 1 at Minneapolis, Minnesota.

Since Wisconsin Power & Light serves an area bordered in part by the Mississippi River and contiguous to other Corps of Engineers locks and dams, we are very much interested in the development and conclusions of the subject studies. We would appreciate receiving copies of these studies and any similar work in progress or proposed, particularly with regard to lock and dam Nos. 9, 10, and 11 at Lynxville, Wisconsin, Guttenberg, Iowa, and Dubuque, Iowa, respectively, which are adjacent to areas we serve.

At this time we have no specific input or suggestions to offer to apply to the work at hand, but are prepared to assist in any way we can. Please do not hesitate to call on us if we can be of service on this or similar work.

Very truly yours,

W.C. Register

W. C. Register
Director of System
Operations and Planning

WCR/jml
cc - Mr. James H. Dudley
Mr. W. L. Keepers

FEDERAL ENERGY REGULATORY COMMISSION
CHICAGO REGIONAL OFFICE
230 SOUTH DEARBORN STREET. ROOM 3130
CHICAGO. ILLINOIS 60604

September 10, 1981

Mr. Louis Kowalski
Chief, Planning Division
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Mr. Jenkins:

Your August 4, 1981 letter requests power values for use in the reconnaissance study for addition of hydropower at Lock & Dam No. 8 at Genoa, Wisconsin. Proposed development would consist of adding 8,750; 10,500 or 14,000 kilowatts of new capacity.

Power values, based on a coal-fueled steam-electric plant as the most likely alternative to each of the proposed hydroelectric developments, are summarized in the attached table. These are "at-market" values; no transmission line costs for the hydroelectric development have been included.

The energy value for the hydroelectric development is determined by the difference in total system operating cost between a system utilizing the proposed hydroelectric installation and one using an equivalent size alternative steam-electric generating plant. Operating costs for the hydroelectric project and its equivalent alternative were simulated using a probabilistic production costing computer model. The POWRSYM Version 48 model was used for this analysis.

Northern States Power Company was used as a "typical" system to measure the annual production cost differences between future operation with the added hydroelectric capacity and its equivalent alternative. Operation of the system was simulated over the period 1980-2010 based on projected load and energy requirements for the Northern States Power Company system.

The capacity values given in the attached table are based on the annual fixed costs to install the alternative electric generating plant. A 5.0 percent credit has been given to the hydroelectric capacity to reflect its greater operating flexibility. In addition, the capacity value for the hydroelectric plant has been adjusted to reflect relative value based on its availability in comparison with the availability of the alternative steam plant. Accordingly, the capacity value given is applicable to the installed capacity of the proposed hydrolectric plant and already incorporates the consideration of dependable capacity.

Energy values are also given in the attached table which recognize the real fuel cost increases associated with multi-year operation of the system. Real fuel cost escalation factors were taken from Department of Energy data published in the October 17, 1980 Federal Register. Discount rates as specified in your letter were used to levelize these costs over the 100 year period requested.

If you have any questions regarding these power values, please contact Mr. David Simon of my staff at (FTS) 353-6701 and he will assist you.

Sincerely,

Lawrence F. Coffill

Lawrence F. Coffill, P.E.
Regional Engineer

Enclosure:
As stated

cc: Deputy Director, OEPR (3) w/encl.
(Attn: Director, DISA)

Simon,D.L./yb

LOCK & DAM NO. 8 AT GENOA, WI ON THE MISSISSIPPI RIVER

Power Values at January 1981 Cost Levels:

Cost of Money %	New Capacity Added (MW)	Additional Generation (MWH)	Capacity Value $/KW-Yr.	Energy Value Current $/MWH	Energy Value Escalated $/MWH
7.375	8.75	46,600	100.00	20.4	41.4
	10.5	53,200	93.70	20.6	41.8
	14.0	62,300	67.40	21.2	41.9
8.5	8.75	46,600	113.20	20.4	40.6
	10.5	53,200	106.00	20.6	41.0
	14.0	62,300	76.2	21.2	41.1
10.0	8.75	46,600	132.50	20.4	39.6
	10.5	53,200	124.20	20.6	40.0
	14.0	62,300	89.30	21.2	40.1
12.0	8.75	46,600	161.50	20.4	38.4
	10.5	53,200	151.30	20.6	38.8
	14.0	62,300	108.80	21.2	39.9

APPENDIX C

HYDROLOGIC POWER AND ENERGY ANALYSIS

APPENDIX C

TABLE OF CONTENTS

LIST OF PLATES

APPENDIX C

PROCEDURES USED IN HYDROLOGIC POWER AND ENERGY ANALYSIS

For a reconnaissance study, there are three main items to be determined for each plant size under consideration, to determine its economic value and relative productivity. These items are the average annual energy, the dependable capacity and the weekly generation. The several options for plant capacity are selected to provide significantly differing levels of development.

In each case, the available flow is considered along with the site conditions, current development, design considerations and ecological constraints. This process gives the best chance of finding an economically feasible and otherwise justifiable project.

Average Annual Energy

The flow duration technique was used to estimate average annual energy production. The daily flows for the period of record are grouped into flow classes. Each flow class is then plotted according to its cumulative percentage of occurrence. The curve (see Plate C-1) is assumed to represent an average year.

Since the head varies significantly with changes in flow, 5 years of data (representing wet, damp, average, dry and very dry years) were compiled to determine a head-versus-flow curve. This gross head was reduced by the estimated trashrack and tailrace losses to produce the curve of estimated net head (also shown on Plate C-1).

The power available depends upon the factors of head (H) and flow (Q). The amount of the power produced by the turbine depends upon these factors and the efficiency of the turbine. The equation for power is used to calculate the power for each flow class:

$$P = \frac{Q \times H}{13.7} \qquad \text{(kW)}$$

As previously noted, this equation assumes an overall efficiency of 0.86. For flows greater than the plant capacity, a mechanical availability of 90% is assumed. When capacity is in excess of flow, 100% availability is assumed. Thus the plant factors shown have included reliability as a consideration.

The estimated power for each flow class and option are plotted on the flow-duration curve. Since the horizontal axis represents an average year, the area under the power curves gives the average annual energy for those options. The calculated values for each flow class and option are shown on table C-2. The average annual energy is used to determine the average annual energy benefit.

Firm Power Evaluation

At certain times of the year, the demand for energy reaches a peak. In the upper midwest region, there are two periods of peak demand, one during July and August, and one during December and January. The firm capacity is estimated for both of the critical periods and for the total year. (See Table C-3.) The firm power estimate given here is intended to indicate the size of conventional plant which would provide the same dependable capacity on the average. This approach considers 1) the sizes of the conventional and hydro plants and 2) their relative availabilities. The formula used is:

$$\text{Capacity Firm, MW} = \frac{(\text{Installed Capacity})(\text{Hydro Plant Factor})}{(\text{Conventional Plant Reliability})}$$

Conventional and nuclear plants in this area have reliabilities from 63 to 95 percent, with an average of 83 percent. For this study, the conventional reliability was assumed to equal 85 percent.

This procedure is essentially that recommended by the staff of the Hydroelectric Design Branch of the North Pacific Division, Corps of Engineers.

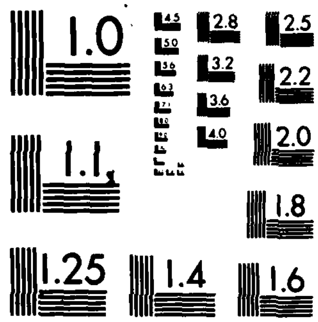
Average Weekly Generation

To calculate the power values to be assigned to a proposed site, the Federal Energy Regulatory Commission (FERC) examines the performance of

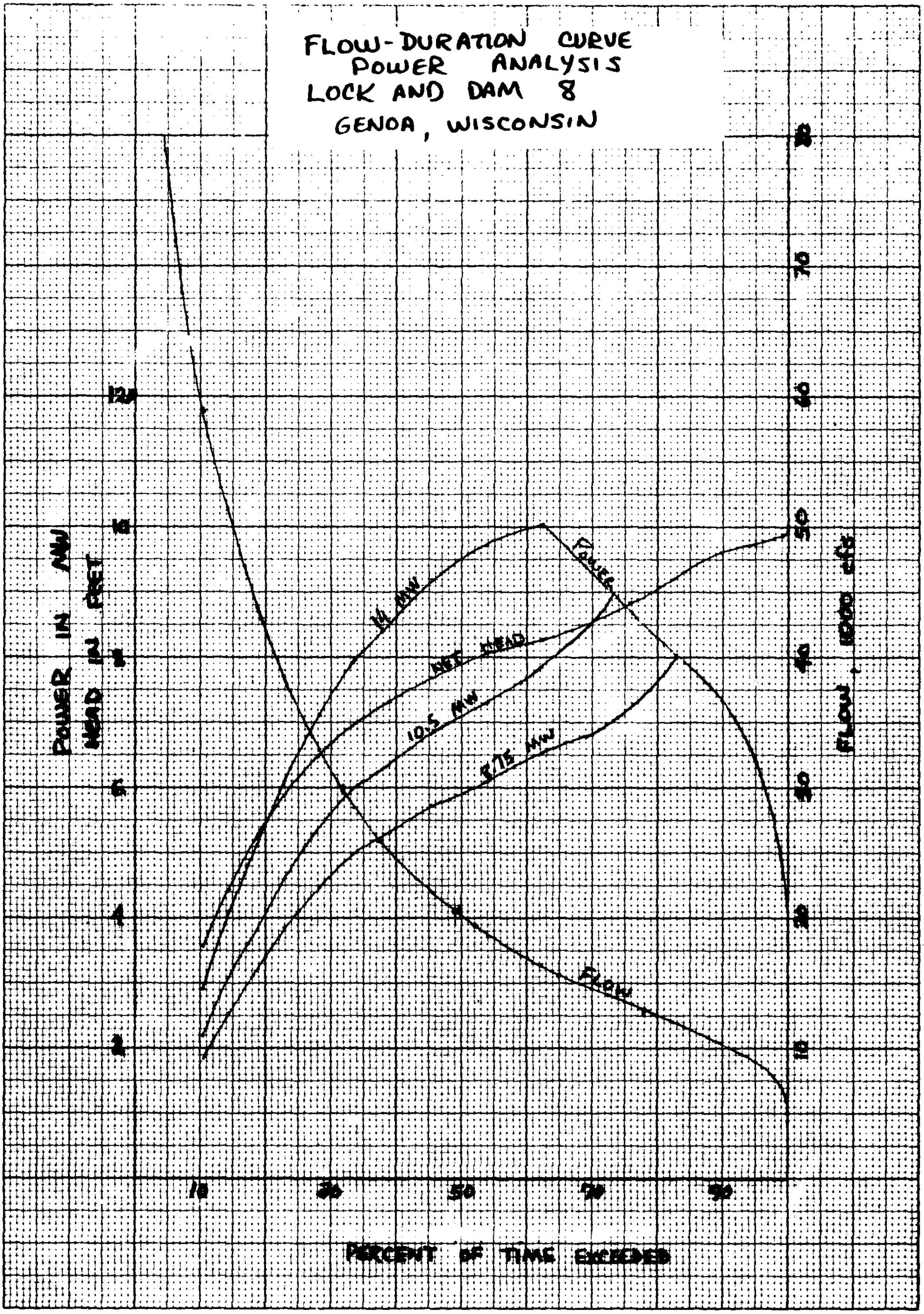
AD-A129 735 RECONNAISSANCE REPORT FOR HYDROPOWER LOCK AND DAM 8 MISSISSIPPI RIVER(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 81 2/2

UNCLASSIFIED F/G 10/2 NL

END
DATE
FILMED
DTIC


1.0
4.5
5.0
5.6
6.3
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

each option within the proposed power network by using a computer program for power network simulation. In order to do this, the proposed generation schedule is required on a weekly basis. Weekly average flows for the period of record were used to calculate weekly power values. These values were adjusted so that the annual totals equal those for the annual flow duration calculations. The average flows and weekly energy for each option are shown on Table C-4.



FLOW-DURATION CURVE
POWER ANALYSIS
LOCK AND DAM 8
GENOA, WISCONSIN
POWER IN MW
HEAD IN FEET
FLOW, 1000 cfs
PERCENT OF TIME EXCEEDED
11 MW
NET HEAD
10.5 MW
8.75 MW
POWER
FLOW
10
30
50
70
90
2
4
6
8
10
12
20
30
40
50
60
70

Plate C-1

COMPUTATION SHEET

Subject: ANNUAL FLOW-DURATION HYDROPOWER ANALYSIS FOR

Computation: LOCK & DAM 8, ST. PAUL, MN.

Computed by: DESIGN HEAD 9.5 ft

Design [illegible]

Checked by: [illegible]

Project: [illegible]

Date: ______ Page ___ of ___ Pages ✓

%-ile	Flow Class	Net Head	#Events 18627	Δ%	10 UNITS @ 875 KW Flow Capacity	Flow Used	Power KW	Energy MWh	12 UNITS @ 875 KW Flow Capacity	Flow Used	Power KW	Energy MWh	16 UNITS @ 875 KW Flow Capacity	Flow Used	Power KW	Energy MWh
4.7	78800	1.4	881	4.7	[illegible]	[illegible]			5304	[illegible]			[illegible]	7439		
7.3	67800	2.6	496	2.7	[illegible]	[illegible]			[illegible]	[illegible]			10547	[illegible]		
[illegible]	59100	3.6	566	3.0	[illegible]	6981	[illegible]	477	[illegible]	[illegible]	2201	556	[illegible]	11169	[illegible]	[illegible]
14.2	51400	4.5	695	3.7	[illegible]	[illegible]	2514	533	10460	9366	3076	1005	[illegible]	[illegible]	4102	1341
18.9	43800	5.2	850	4.6	[illegible]	7210	3184	[illegible]	11186	10068	[illegible]	[illegible]	14915	13424	5095	2637
22.8	32300	5.9	763	4.1	7730	7937	3849	1381	11916	10724	4618	1657	15827	[illegible]	[illegible]	2210
28.1	32800	6.5	986	5.3	10422	9380	4450	2264	12507	11256	5341	2476	16676	15008	[illegible]	3302
[illegible]	28400	7.0	[illegible]	5.2	10816	9731	4974	2255	[illegible]	11681	5968	2703	[illegible]	15575	[illegible]	3604
38.9	25200	7.3	1043	5.6	11045	9941	5299	2578	13254	11929	[illegible]	3118	17672	15905	8475	4157
[illegible]	21900	7.7	1222	6.6	11344	10209	[illegible]	2298	13612	12251	6556	3959	18150	16335	9181	5796
53.9	18600	8.0	1565	8.4	11563	10406	6077	4451	13875	12488	7292	5317	19500	[illegible]	[illegible]	7170
62.4	16400	8.4	1571	8.5	11849	[illegible]	6539	[illegible]	14218	12796	7846	5860	18951	[illegible]	[illegible]	[illegible]
72.5	14200	8.7	1875	10.1	[illegible]	[illegible]	6891	[illegible]	14469	14200	9015	7958	19292	[illegible]	[illegible]	7952
82.2	12000	9.2	1839	9.9	12399	[illegible]	[illegible]	[illegible]	[illegible]	12000	8053	[illegible]	19839	[illegible]	8053	6767
89.6	10400	9.7	[illegible]	7.3	12732	10400	7364	4397	[illegible]	10400	7364	4397	20371	10400	[illegible]	4397
94.9	9000	9.8	990	5.3	[illegible]	9000	6432	2971	[illegible]	9000	6432	2971	20476	9000	6432	2971
97.7	7800	9.8	512	2.7	12797	7800	5530	1343	[illegible]	7800	5550	1343	20476	7800	5550	1343
99.1	6800	9.9	261	1.4	12863	6800	4914	603	15435	6800	4914	603	20580	[illegible]	4914	603
99.8	5800	9.9	128	0.7	12863	[illegible]	4191	[illegible]	15435	5800	4191	252	20580	5800	4191	252
100.0	5000	10.0	41	[illegible]	12927	5000	3650	70	15513	5000	3650	70	[illegible]	5000	[illegible]	70
								46577				53165				62287
		AVG. ANNUAL ENERGY MWh						46600				53200				62300
		OVERALL PLANT FACTOR						.61				.58				.51
		INCREMENTAL PLANT FACTOR						N/A			over existing	.43			over existing	.34
		INCREMENTAL PRODUCTION FACTOR				$\frac{\text{\% INCREASE IN PRODUCTION}}{\text{\% INCREASE IN CAPACITY}}$						14.1/20	= .705		over 19.25 MW	.30
															19.6/33	= .594

NCS Form 53
17 Aug 77

Plate C-2

COMPUTATION SHEET

Subject: (8) LOCK AND DAM 8 DEPENDABLE CAPACITY

Project: BASED ON FLOWS AT WINONA

Computation: 2 CRITICAL PERIODS - JUL-AUG, DEC-JAN

Computed by: DESIGN HEAD 9.5 ft. — DESIGN FLOW PER TURBINE = 1260 cfs — c = 0.86

Checked by: D.A = 64770 mi²

Date ____ Page ____ of ____ Pages

FLOW CLASS	NET HEAD	%-ile	# EVENTS OF 3224	Δ%	ENERGY JUL-AUG 10 @ 875KW (8.75 MW) OPTION 1	12 @ 875KW (10.50 MW) OPTION 2	16 @ 875KW (14.0 MW) OPTION 3	%-ile	# EVENTS OF 3162	Δ%	ENERGY DEC-JAN 10 @ 875KW (8.75 MW) OPTION 1	12 @ 875KW (10.50 MW) OPTION 2	16 @ 875KW (14.0 MW) OPTION 3
73800	1.4	2.2	73					0.0	0				
67[illegible]00	2.6	4.6	77					0.0	0				
59100	3.6	6.9	73	2.3	364	437	509	0.0	0	0.0	0	0	0
51400	4.5	10.3	108	[illegible]	750	903	1253	0.0	1	0.0	7	9	10
43800	5.2	14.0	120	3.7	1032	1246	1454	0.6	18	0.6	159	191	222
38200	5.9	17.9	126	2.9	1318	1581	1345	1.4	24	0.8	256	307	358
32800	6.5	24.4	211	6.5	2551	3062	3572	2.6	39	1.2	481	[illegible]	513
28400	7.0	32.9	207	6.4	2797	3357	[illegible]916	4.9	74	2.3	[illegible]020	1224	1429
25200	7.3	37.2	203	6.3	2922	3506	[illegible]090	7.8	92	2.9	1350	1620	1890
21900	7.7	45.4	265	8.2	4132	4956	[illegible]784	13.9	191	6.0	3036	3644	4251
18600	8.0	55.0	310	9.[illegible]	5118	6142	[illegible]166	24.2	327	10.3	5505	6606	7707
16400	8.4	61.2	200	6.2	3553	4264	[illegible]464	36.5	388	12.3	7022	[illegible]433	10809
14300	[illegible]	69.8	277	8.6	5187	6787	6787	55.0	584	18.5	11150	14590	14590
12600	9.2	80.0	329	10.2	7172	7[illegible]22	[illegible]182	70.2	482	15.2	10761	10761	10761
10400	9.7	[illegible]	242	7.5	4842	4842	4842	82.0	372	11.8	[illegible]	[illegible]	7989
9000	9.8	93.4	192	6.0	3359	3359	[illegible]359	91.0	284	9.0	5065	5065	5065
7800	9.8	96.2	91	2.8	1390	1390	1390	95.6	146	4.6	2257	2257	2257
6800	9.9	97.4	38	1.2	507	507	507	98.5	91	2.9	1239	1239	1239
5800	9.9	99.3	62	1.9	706	706	706	99.5	30	1.0	372	372	372
5000	10.0	100.0	21	0.7	208	208	208	100.0	17	0.5	172	172	172
AVG ANNUAL ENERGY, MWh					47916	54425	51824				57445	64653	69391
ASSUMED COAL/NUC RELIABILITY					.85	.85	.85				.85	.85	.85
CRITICAL PERIOD DEP. CAP.					6.4	7.3	8.0				7.7	8.7	9.3

NCS Form 53
17 Aug 77

Plate C-3

COMPUTATION SHEET

NAME OF OFFICE | COMPUTATION | DATE 7/24/81 | PAGE 1 OF PAGES 2

SUBJECT: LOCK AND DAM 8 WEEKLY GENERATION – ADJUSTED

ABSOLUTE VALUE ÷ ① 0.992232, ② 1.045771, ③ 1.134414

PRICE LEVEL

COMPUTED BY | CHECKED BY | APPROVED BY

WEEK	FLOW @ WINONA	NET HEAD	X1.094 ADJUSTED FLOW③		WEEKLY GENERATION ANN. ① 8.75 MW	② 10.5 MW	③ 14.0 MW		
1	14196	8.6	15530		1147	1305	1419		
2	13611	8.8	14890		1187	1351	1392		
3	13654	8.7	14937		1167	1328	1381		
4	13486	8.8	14754		1187	1351	1379		
5	13240	8.8	14485		1187	1495	1354		
6	13455	8.8	14720		1187	1351	1376		
7	13935	8.7	15245		1167	1328	1409		
8	14254	8.6	15594		1147	1305	1425		
9	16492	8.3	18042		1087	1238	1590		
10	19336	8.0	21154		1029	1171	1415		
11	23236	7.5	25420		934	1063	1285		
12	31645	6.6	34620		771	878	1060		
13	41694	5.6	45613		603	686	829		
14	50554	4.5	55306		434	494	597		
15	58286	3.7	63765		324	368	445		
16	64261	3.0	70302		236	269	325		
17	58947	3.6	64488		310	354	427		
18	52694	4.3	57647		405	462	558		
19	48346	4.8	52891		478	544	657		
20	44271	5.2	48432		539	614	742		
21	40651	5.6	44472		603	686	829		
22	39020	5.8	42688		635	723	873		
23	39140	5.8	42819		635	723	873		
24	36976	6.0	40452		668	761	919		
25	37377	5.9	40890		652	742	897		
26	36962	6.0	40436		668	761	919		

NCS Form 18 22 Dec 75

COMPUTATION SHEET

NAME OF OFFICE | COMPUTATION | DATE 7/24/81 | PAGE 2 OF 2 PAGES

SUBJECT: LOCK AND DAM 8 WEEKLY GENERATION – ADJUSTED

ABSOLUTE VALUE – ÷ (1) 0.992232, (2) 1.045771, (3) 1.15944

PRICE LEVEL

COMPUTED BY | CHECKED BY | APPROVED BY

WEEK	FLOW @ WINONA	NET HEAD	x 1.094 ADJUSTED FLOW (8)		WEEKLY GENERATION MWH (1) 9.75 MW	(2) 10.5 MW	(3) 14.0 MW		
27	34964	6.2	38251		702	799	965		
28	31202	6.7	34135		788	898	1085		
29	25540	7.3	27941		897	1021	1234		
30	22171	7.7	24255		972	1106	1336		
31	21130	7.8	23116		991	1127	1363		
32	20047	7.9	21931		1010	1149	1389		
33	18987	8.1	20772		1048	1193	1441		
34	17755	8.1	19424		1048	1193	1441		
35	18225	8.1	19938		1048	1193	1441		
36	20092	7.8	21981		991	1127	1363		
37	20273	7.8	22179		991	1127	1363		
38	20024	7.9	21906		1010	1149	1389		
39	20148	7.9	22042		1010	1149	1389		
40	18714	8.0	20473		1029	1171	1415		
41	18371	8.1	20098		1048	1193	1441		
42	18909	8.0	20686		1029	1171	1415		
43	18891	8.0	20667		1029	1171	1415		
44	19853	7.9	21719		1010	1149	1389		
45	20795	7.8	22750		990	1127	1363		
46	20435	7.9	22356		1010	1149	1389		
47	19615	8.0	21459		1029	1171	1415		
48	17467	8.2	19109		1067	1215	1468		
49	16239	8.3	17765		1087	1238	1566		
50	14551	8.6	15809		1147	1305	1444		
51	15450	8.4	16902		1107	1260	1508		
52	15223	8.5	16654		1127	1283	1504		
		TOTALS			46600	53200	62300		

NCS Form 15 22 Dec. 75

APPENDIX D

PLAN OF STUDY

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FIGURES

NUMBER		

APPENDIX D

PLAN OF STUDY

REPORTS DEVELOPED

STAGE I - RECONNAISSANCE STUDY

The study for hydropower addition will be conducted in two stages. During the first stage, principal emphasis is on identification of resource management problems, concerns, and opportunities. Because of the introductory nature of the planning process in this stage, the effort involves analyzing a wide range of data, which may be more qualitative than quantitative. The general purpose of this stage is to initially analyze the water and related management problems and opportunities and evaluate in a preliminary fashion alternative solutions. The product of Stage I is a reconnaissance report which shows the results of the analysis; recommends or terminates further study; and, if further studies are recommended, outlines a plan for future studies.

STAGE II - FEASIBILITY STUDY

The feasibility report analyzes differences among alternatives and the corresponding effects of trade-offs between the national economic development and environmental quality objectives. Major study efforts will involve collection and evaluation of required data and formulation of an optimum scale of development. Recommendations will be made in the report for authorization of the plan selected. However, the authorization by Congress, advance planning, and funding by Congress will be necessary before any of the measures recommended in the feasibility report could be developed.

PUBLIC INVOLVEMENT

PUBLIC PARTICIPATION

The objective of public involvement is to actively involve the public in hydropower studies to ensure that these studies respond to public needs and preferences to the maximum extent possible, within the bounds of local, State, and Federal programs, responsibilities, and authorities.

The public is any affected or interested non-Corps of Engineers entity including other Federal, regional, State, and local government entities and officials; public and private organizations; and individuals.

To be responsive to public needs and preferences, Corps planning must include a continuous dialogue between the Corps and the public. The need for cooperation and coordination among Federal agencies concerned with water resources development has become more apparent as the Federal interest in this activity has grown. The interests of affected States and involved local interests are significant concerns and must be recognized and considered. In recent years, this has been amplified by general concern for the environment, regional economic development, and social well-being. It is the policy of the Corps to coordinate the hydropower program and to resolve differences wherever possible. To accommodate this dialogue, cooperation, and coordination, the Corps will hold workshop meetings periodically to discuss study progress and elicit reaction to potential proposals.

PUBLIC MEETINGS

In addition to developing an effective public involvement program through citizen and agency coordination and informal workshops, the Corps will hold two official public meetings to afford all interests full opportunity to express their views and furnish specific data on matters pertinent to the study. These meetings will be held after initial public contacts and preliminary studies are undertaken through consultation with the agencies and the public. The purpose of each meeting is described as follows:

a. At the completion of the reconnaissance study, when alternative solutions are known but before a plan has been tentatively selected, a midstudy public meeting will be held. A major purpose of this meeting is to present the results of preliminary studies including the advantages and disadvantages of the various alternatives to the extent that such information has been developed and to further develop public views and desires, particularly as they relate to the various alternatives.

b. A late-stage public meeting will be held after detailed studies and before feasibility report completion. Findings of the detailed studies, including the rationale for any proposed solution, and the tentative recommendations will be presented. This meeting will ensure that any plan presented would be acceptable.

STUDIES REQUIRED

PLANNING

Planning studies will assess the power potential and issues related to its development. Alternative solutions will be investigated. Current formulation criteria and policies will be used to evaluate the development of alternative plans incorporating both nonstructural[1] and structural measures as appropriate. Analysis of alternatives and impacts of trade-offs among national economic development, environmental quality, and social well-being will be assessed in selection of the best solution. The major study effort will be to select a final plan that best meets overall needs and formulate the optimum scale of project development. As an integral part of the planning effort, coordination will be maintained with the public throughout all stages of the study. Report preparation and development will be a specific responsibility of this study element. Also, by using sound planning practices the study schedule will be maintained.

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(1) Nonstructural alternatives are not required for small-scale hydropower projects of 25 MW or less.

ECONOMIC AND FINANCIAL ANALYSIS

The economic analysis deals primarily with development and application of benefit-cost analysis which is the most frequently used and accepted procedure for project economic evaluation. The objective of this analysis is to relate all project economic benefits to all project costs accruing to the project.

Studies to evaluate the economic worthiness of the project will include formulation of alternative project cost and benefit streams, screening and ranking of alternatives, benefit-cost analysis, and determination of risk and uncertainty related to project outcomes.

Average annual costs, using current interest rates, will be determined within the St. Paul District office. Annualized power value benefits will be supplied by the Federal Energy Regulatory Commission (see the section entitled "Power Value Analysis" in this appendix).

Financial feasibility deals with a project's ability to obtain funds for implementation and repay these funds on a self-liquidating basis. If the project is financed and operated by the Federal Government, financial feasibility loses meaning because the project does not have to be selr-liquidating in the short run and federally established interest rates would be used for financial comparison. In this case, the economic and financial analysis would essentially be the same.

A financial analysis for the project, however, will be done based on non-Federal funding and operation. This analysis will consider the overall credit market at the time of study completion as it relates to possible funding of a hydroproject; inflation factors and how they affect the cost of capital, cash receipts, and cash disbursements; and determination of the project's minimum reverse requirement including a sensitivity analysis of risk.

ENGINEERING

The types of engineering studies that will be performed include hydrologic power evaluation, foundation, mechanical and electrical, civil features, and design and cost studies. All of the studies undertaken will be accomplished using appropriate engineering standards, regulations, and guidelines and will be summarized in a report appendix for each study.

Hydrologic Power Evaluation

Hydrologic power evaluation establishes how much water can be diverted through the turbines and the hydraulic head associated with this flow. Studies for evaluation of power will essentially be an update and refinement of the technique used in the reconnaissance study.

Related studies concerning the flow pattern changes resulting from hydropower plant construction may be required. However, provision for a physical model study which would completely evaluate flow changes is not included in the work schedule and cost estimate section of this appendix. Such a study is considered unwarranted at this time.

Foundation Studies

Foundation studies will consist of the necessary instrument surveys to supplement existing boring and topography information in areas of any considered improvements. Sufficient foundation investigations will be made to determine the type and engineering characteristics of soils in any development area from field examinations of exposed cuts and channel banks and from research of existing available boring data. Additional soil borings and subsequent tests will be completed as appropriate.

Power plant channel design will include riprap if necessary. Final design of riprap will determine gradation, thickness, size and extent, and other erosion or scour preventive features. These designs will conform to current design methods and criteria.

Embankments will be designed which are safe against overtopping during occurrence of the design flood and stable and safe under extremes of operation. The embankments will be designed so as not to impose excessive stresses on the foundation materials, have slopes that are stable under all conditions of impoundment operations, and provide for control of seepage through the embankment foundation and abutments as necessary. Final designs will conform to current design criteria.

Mechanical and Electrical Features

Mechanical and electrical features convert the water's energy to electricity. These features also control the energy and transmit it to a power grid.

Studies will include evaluation of major equipment items such as the hydraulic turbines; electrical generators; and a switchyard consisting of a transformer, circuit breaker, and switchgear. Included also are supporting systems which control and protect these major equipment items. Evaluation of maintenance facilities such as a crane for lifting is also included under mechanical and electrical features investigations.

Because of plant size and likely marginal economic feasibility, standardized turbines and complete generating sets will be evaluated for application. In addition, relaxing the need for some of the traditional control and protection equipment will be assessed.

Civil Features

The civil features of small hydropower additions include site preparation works, hydraulic conveyance facilities, and powerhouse and appurtenant facilities.

Site preparation includes grading, foundation excavation, drainage and erosion control, access roads and parking facilities, and construction noise abatement and dust control. Hydraulic conveyance facilities include penstocks, tunnels, canals, valves and gates, inlet and outlet works, and tailrac

Powerhouse and appurtenant facilities include all structures for powerhouse and equipment handling facilities, foundations for both the powerhouse and switchyard, and fencing around the project area.

The civil features of small hydropower additions differ from those of major hydropower installations. Feasibility of the project may hinge upon adequate yet innovative designs for civil features. Therefore, studies in addition to evaluating the above features will include the analysis of appropriate outdoor type plants, portable lifting equipment for maintenance, and reduction in normal protection equipment.

Designs and Cost Estimates

Detailed project scope structural designs for all alternative features will be undertaken. Such designs will be in accordance with accepted criteria and guidelines. Design work will also include drafting of all report charts, illustrations, and plates in accordance with drafting standards. A detailed estimate of first costs will be accomplished including appropriate allowances for advance engineering, design, and contingencies. The estimates of first costs will reflect prevailing price levels for similar work in the area and be based on recent price information. An estimate of annual costs including appropriate allowances for operation, maintenance, and scheduled replacement of major project features will be prepared. These annual costs will be based on the interest rate prevailing at the time of report completion.

MARKETING ANALYSIS

The Department of Energy (DOE) is responsible for performing market analysis for Federal hydropower projects. The DOE will be provided a copy of this reconnaissance report and other data it believes it needs to complete its analysis. Its output would be a statement that power which the project would produce could be marketed at a price that would ensure repayment of project costs plus interest and operation, maintenance, and major replacement costs within the required 50-year period. Results of the marketing analysis will be included in the feasibility study.

POWER VALUE ANALYSIS

Hydroelectric developments must be planned and evaluated as components of comprehensive river basin plans as well as units of the electric power supply systems in which they are incorporated. In regard to the above, the Federal Energy Regulatory Commission (FERC) provides input to determine financial and economic feasibility of Federal hydropower projects.

Benefits attributable to the hydropower projects are determined and furnished by FERC in close coordination with the DOE and will be used in the above-mentioned economic and financial feasibility analysis. Power values are the benefits produced by a hydroelectric plant and reflect a measure of society's willingness to pay for the power produced. Because willingness to pay cannot be directly measured, power values are based on the surrogate costs of constructing and operating the most probable alternative if the hydropower project is not constructed. This cost is given as an investment cost (capacity values) necessary to construct the most probable alternative and the production cost (energy value) which results from operation of the alternative.

ENVIRONMENTAL RESOURCES

The potential for hydropower development is being investigated at several of the locks and dams within the district. Environmental studies will be undertaken to identify the impacts of alternatives on the natural and human environment. Specific studies will be undertaken in the categories of natural resources, cultural resources, and social effects.

Natural Resources

The objectives of natural resources studies would be to:

a. Identify the principal natural resources of the study area.

b. Determine those significant resources which would be affected by hydropower development.

c. Predict the potential environmental impacts of each alternative.

d. Identify opportunities for restoration and enhancement of the environment.

e. Recommend strategies for minimizing or eliminating impacts.

Natural resources studies conducted at one or more of the dams would be applicable to all because of the basic similarities among all the structures.

The tail water, the area immediately downstream of a dam, provides a valuable and heavily utilized fishery resource at many of the dams on the Upper Mississippi River. Studies would be conducted to determine what factors (e.g., current velocity, water depth) are of critical importance to the fishery and what effect the installation of hydropower would have on those factors.

The diversion of the majority of the river flow through turbines would have the potential to reduce dissolved oxygen levels. Studies would be made to predict possible reductions by determining existing oxygen values. Methods of improving aeration during power generation would be investigated.

An area of concern in power generation is the potential for entrainment (organisms drawn toward or into the turbine tube) or impingement (organisms trapped on trash collection screens). The possible extent of entrainment and impingement would be investigated. Screening and intake designs which would minimize the effects would be reviewed as well.

It is known that various species of fish, including white bass and sauger, move upstream from pool to pool. The extent and importance of this movement is not well understood. The effect of hydropower development on this phenomenon and the consequences would be investigated.

The placement of cofferdams and other excavated material as well as excavation itself (e.g., headrace, tailrace channels) would be detrimental to aquatic communities through habitat destruction or burial of organisms. The possible extent of such activities and methods of minimizing them would be investigated.

Studies would also be conducted to evaluate impacts on the unique significant resources of each individual hydropower site. Opportunities to restore or enhance previously disrupted resources would be sought at each individual site.

Recreation

The recreation studies will investigate and document any recreation resource related needs, as identified by prior studies, that could be satisfied by feasible recreation features incorporated in the national economic development, environmental quality, and recommended plans of improvement. Appropriate drawings, sketches, or illustrations showing any proposed recreation facilities will be included in the feasibility report along with associated cost estimates. The location and extent of any lands required for recreation resource development measures will be identified. Annual average recreation benefits attributable to the provision of new recreation resources will be determined in accordance with accepted guidelines. The need for and provision of project-related recreation measures will be analyzed in light of Corps Resource Management Plans and local and State recreation needs as identified in appropriate State Comprehensive Outdoor Recreation Plans. Project-related recreation features that might be considered include, but are not limited to, picnicking facilities, boat docks, fishing areas, hiking and biking paths, scenic overlook and pedestrian bridges, and other river related accesses. Provisions for use of facilities by the elderly and handicapped will be considered in the design of any recreation features.

Recreation studies will be closely coordinated with environmental and cultural investigations to assure compatibility among proposed design features.

Social

Investigations conducted during the feasibility study will analyze the social effects construction activities have on employment, community services, safety and health, noise and air pollution, and local transportation. Social effects resulting from energy requirements and conservation will also be assessed. In addition, should significant amounts of transmission facilities be required, impacts on property acquisition and relocation, community cohesion, aesthetic quality, and land use will also be assessed.

Institutional studies will investigate the consistency and impact of Corps facilities with existing power generation and distribution systems.

Cultural Resources

Because of the extensive prehistorical and historical use of the Mississippi River valley, actions related to hydropower development, such as powerline construction, stream diversion, channel flow changes, access road construction, powerhouse construction and riprapping, would be preceded by a cultural resource study. Coordination with the National Park Service, the State Historic Preservation Officer, and the State Archeologist will be initiated.

INTRAOFFICE COORDINATION

The requirements of the planning process necessitate an interdisciplinary planning approach to identify and define the planning objectives, develop creative alternative plans, and analyze a broad range of complex issues, including the probable economic, social, and environmental consequences of plan implementation. This is best accomplished by a planning team which employs a diversity of professional skills.

WORK SCHEDULE AND STUDY COST ESTIMATE

The feasibility study is scheduled to be completed in spring 1985. Dates for the applicable study milestones are presented in the following table.

Milestone schedule

Milestone number	Designation	Completion
6	Submission of draft feasibility report	Fall 1984
7	Stage 3 (Stage 2 for hydropower studies) checkpoint conference	Fall 1984
8	Completion of action on conference MFR	Fall 1984
9	Coordination of draft environmental impact statement	Winter 1984-1985
10	Submission of final feasibility report and revised draft environmental impact statement to Division	Spring 1985

To accomplish the schedule, the Corps needs funds as follows:

Fiscal year	Amount
1981	$10,000
1982	10,000
1983	195,000
1984	170,000
1985	25,000
Total	410,000

The study cost estimate (PB-6) shows the breakdown of that funding. The steps following submission of the feasibility report to authorization by Congress are shown on the following figure

RCS: L. .l-CWB-12

STUDY COST ESTIMATE (PB-6) (6008)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations

CATEGORY: Survey

CLASS: Flood Control

NAME OF STUDY: MISSISSIPPI RIVER, COON RAPIDS DAM To The Mouth of the Ohio River INTERIM REPORT #19 (L&D 8)

SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT FEDERAL COST ESTIMATE – ACCOUNT STAGE 1	STAGE 2	STAGE 3	TOTAL	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED 10 Oct 80	REMARKS
	a	b	c	d	e	f	g	h
1	.00	Costs thru 30 Sep 78						
2	.01	Public Involvement	1		15	16	16	
3	.02	Institutional Studies	0		5	5	1	
4	.03	Social Studies	0		13	13	2	
5	.04	Cultural Resource Studies	0		5	5	5	
6	.05	Environmental Studies	1		67	68	29	Increase due to refinement of environmental requirements.
7	.06	Fish & Wildlife Studies	1		6	7	7	
8	.07	Economic Studies	1		11	12	29	
9	.08	Surveys & Mapping	0		7	7	7	
10	.09	Hydraulics & Hydrology Invest.	0		18	18	29	
11	.10	Foundation & Materials Invest.	3		30	33	19	Increase due to revised estimate of work required.
12	.11	Design & Cost Estimates	1		80	81	28	Increase for detailed design required in DPR.
13	.12	Real Estate Studies	0		2	2	2	
14	.13	Study Management	1		18	19	24	

DATE PREPARED: 19 Jun 81 | DIVISION: North Central | DISTRICT: Rock Island | REGION: UPPER MISSISSIPPI | BASIN:

ENG FORM 1 APR 77 2204 EDITION OF 4 JAN 71 IS OBSOLETE.

RCS: DAEN-CWB-12

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations

CATEGORY: Survey

CLASS: Flood Control

NAME OF STUDY: MISSISSIPPI RIVER, COON RAPIDS DAM To The Mouth of the Ohio River INTERIM REPORT #19 (L&D 8)

SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT FEDERAL COST ESTIMATE: ACCOUNT STAGE 1	STAGE 2	STAGE 3	TOTAL	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED (10 Oct 80)	REMARKS
	a	b	c	d	e	f	g	h
1	.14	Plan Formulation	0		9	9	9	
2	.15	Report Preparation	0		18	18	18	
3	.20	Other Studies	0		40	40	59	
4		Mechanical and Electrical			(40)	(40)	(59)	
5	.31	Supervision and Administration	1		56	57	41	
6								
7								
8								
9								
10								
11								
12								
13								
14		TOTAL	10		400	410	325	

DATE PREPARED: 19 Jun 81

DIVISION: North Central

DISTRICT: Rock Island

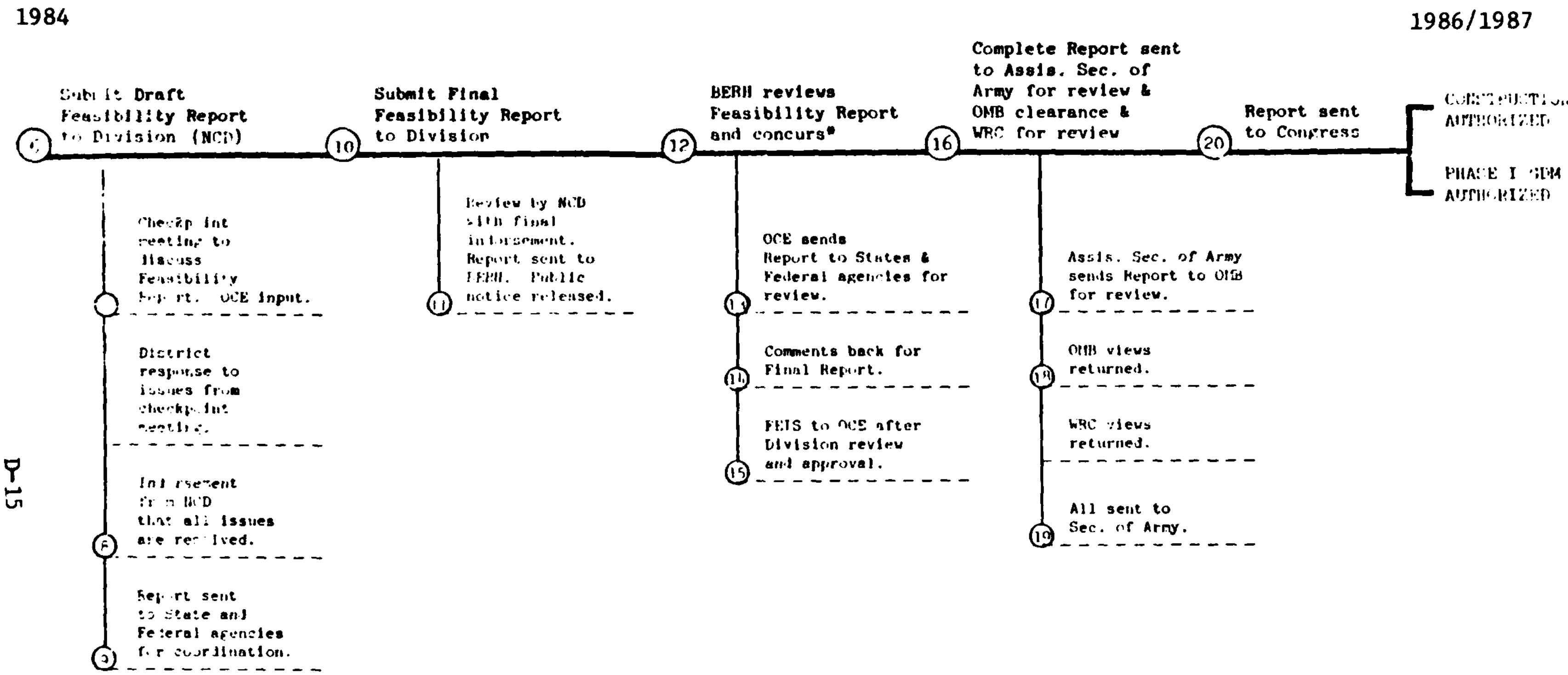
REGION: Upper Mississippi

BASIN:

Page 39 of 43

ENG FORM 1 APR 2204 EDITION OF 4 JAN 71 IS OBSOLETE.

PROCEDURE FOR APPROVAL OF FEASIBILITY REPORT



* a) OCE provides input on policy and engineering.
b) If BERH does not concur they may return the report; request more information; or issue a differing report.
c) If BERH does concur they submit a statement of recommendations with the Report

LEGEND

(1) _ _ Milestone number

APPENDIX E

ENVIRONMENTAL ANALYSIS

TABLE OF CONTENTS

TABLE

APPENDIX E

ENVIRONMENTAL ANALYSIS

ENVIRONMENTAL SETTING

STUDY AREA

The study focuses on the area which would be affected by hydropower generation at lock and dam 8. This area extends along the Mississippi River from La Crosse, Wisconsin, to near Lynxville, Wisconsin, and includes navigation pools 8 and 9. Of primary concern are the areas immediately upstream and downstream of lock and dam 8 and any adjacent lands which may be proposed as corridors for transmission lines.

NATURAL RESOURCES

Physical Setting

The main geographical feature of the region is the Mississippi River valley. The valley in the study area ranges from about 2 to 5 miles in width and is bordered by bluffs which rise from 400 to 500 feet above the level of the river. In the vicinity of lock and dam 8 the river valley is about 2.5 miles wide with the river channel occupying the eastern one-fourth mile of the valley.

The floodplain soils are alluvial materials deposited since the last glacial period (10,000 to 20,000 years ago). The soils are clay, silt, and loam, sometimes sandy and often dark with organic matter. The subsoil is sand, which grades to coarser gravel and sand. Soils of the wetland areas are peaty and dark, derived from decaying organic matter. The soils of the floodplain are underlain by glacial outwash. Soils of the uplands in the study area are complex, with sandy loams on the stream terraces and heavier loess-derived soils farther inland.

The climate of the study area is humid-continental, with wide temperature extremes. The yearly average temperature is 46° F and the average annual precipitation is about 29 inches.

Terrestrial Resources

Vegetation - The woodlands in the watershed adjacent to most areas of the Upper Mississippi River can be divided into two general groups; the upland xeric southern forests of Wisconsin and Minnesota, and the southern lowland vegetation of the floodplain. The upland xeric forests are predominately oak forests (white oak, red oak, and black oak). They are located on well-drained sites on either sandy and porous flat lands, on south and west slopes of hills, or on thin soils on hilltops and ridges.

In the floodplain areas on the pioneer sites along sandbars, mud flats, and other open places of recent soil disturbance, the usual forest is dominated by black willow and cottonwood. On open sites near the upland edge of the wet ground, river birch or swamp oak are the usual dominants. As both of these types mature, they are invaded by silver maple and American elm. A summary of the vegetation composition (in acres) of pools 8 and 9 is given in table E-1.

Table E-1 - Composition of the floodplain in pools 8 and 9[(1)]

Habitat type (acres)	Pool 8	Pool 9
Length of pool (miles)	23.2	31.3
Open water	14,963	20,068
Main channel	4,297	4,472
Side channels	4,978	1,979
Sloughs	3,640	6,218
Ponds	278	1,054
Lakes	1,311	6,216
River (other than Mississippi)	430	77
Other	29	52
Aquatic and marsh vegetation	10,820	15,101
[illegible] and herbaceous vegetation	3,100	1,408
Woody vegetation	6,832	14,465

(1) From: Minor, et. al., 1977.

Wildlife - Much of the floodplain area in pools 8 and 9 is managed as part of the Upper Mississippi River Wild Life and Fish Refuge. The extensive bottomlands provide much valuable wildlife habitat. White-tailed deer, fox squirrel, gray squirrel, cottontail rabbit, and ruffed grouse are important terrestrial game species. Furbearers such as muskrat and beaver are common. Trapping is an economically significant activity in the study area. The Mississippi bottomlands in the vicinity of lock and dam 8, especially the Reno Bottoms, Big Lake, and Winneshiek slough, are noted as feeding and resting areas for a variety of migratory waterfowl and also provide excellent habitat for many nongame species.

Aquatic Resources

Water Bodies - The Mississippi River within the study area is impounded by lock and dam 8 at Genoa, Wisconsin, and by lock and dam 9 at Lynxville, Wisconsin, to form navigation pools 8 and 9 of the waterway system. The Root River and La Crosse River are tributaries in pool 8, and the Bad Ax and Upper Iowa Rivers are tributaries in pool 9. The specific hydrological characteristics at lock and dam 8 are discussed in the Hydrology and Power Potential Section. A summary of the land and habitat composition of pools 8 and 9 is given in table E-1.

Water Quality - In general, the water quality of the Mississippi River in the study area is good. The hardness of the water is moderate, with total hardness rarely exceeding 175 mg/l $CaCO_3$. Aeration characteristics maintain the dissolved oxygen in excess of 60 percent during all parts of the year (COE, 1974). The water has a brown color from the dissolved organic substances leached from forest floor areas.

Two potential sources of poor water quality are found in the project area. The La Crosse Municipal sewage treatment plant discharges 15 million gallons per day of treated effluent into the upper end of pool 8, and the Dairyland Power Nuclear Generating Station at Genoa discharges heated water from the main condenser just below lock and dam 8. Both of these sources are currently well within applicable compliance standards.

Fisheries - The extensive water area and diversity of fish habitat in pools 8 and 9 of the Mississippi River support an abundant and diverse fishery. Eight-six species of fish have been reported from pool 8 and 80 species of fish have been reported from pool 9 (Rasmussen, 1979). This reach of the Mississippi River has provided sport and commercial fishing throughout man's development of the region.

The sport fish harvest has been relatively constant in magnitude, and the diversity of sport fish species ensures some stability to sport fishing in the area. No specific data are available on sport fish harvest in pools 8 and 9; however, important fishing areas include the tail waters below lock and dam 8 as well as the areas near the wing dams.

The commercial fishery in pools 8 and 9 is of economic significance. The average annual total catch between 1973 and 1977 was about 905,000 pounds for pool 8 and 1,941,000 pounds for pool 9 (Rasmussen, 1979). Carp, buffalo, catfish, and freshwater drum are the commonly harvested fish. Pool 9 has the largest commercial harvest of any other pool on the Upper Mississippi River, thereby demonstrating the value of its commercial fishery. Some commercial clamming is also done in pool 9 although most clamming is done in pool 10.

Wetlands - The abundance and diversity of fish and wildlife in the study area are supported by a complex riverine wetland system. A variety of wetland habitat occurs in the Mississippi River floodplain. Some of the most valuable areas in pools 8 and 9 include the Reno Bottoms, Big Lake, and Winneshiek slough. Vegetation ranging from submerged aquatic plants to bottomland hardwood forests provide scenic diversity and valuable habitat.

Significant Natural Resources of the Study Area

The following resources of the study area are resources that are considered outstanding, critical, unique, and deserving of protection.

Wetland Areas - The wetlands in the study area provide valuable habitat for numerous game and nongame wildlife species. A heron and egret rookery exists in the delta of the Root River, and the extensive backwater areas provide feeding and resting habitat for a variety of migratory waterfowl. The Reno Bottoms, Big Lake, and Winneshiek Slough are especially valuable areas which provide excellent opportunity for hunting and fishing in addition to the outstanding fish and wildlife habitat. These wetland areas are widely recognized as significant resources and are protected by several Federal, State, and local laws.

Fishery - The sport and commercial fishery of pools 8 and 9 is a significant resource. Of special significance are the tail-water areas below the locks and dams. These areas of riverine habitat provide the flow and substrate requirements necessary to maintain good game fish populations. Consequently, the tail-water areas provide some of the best sport fishing on the river.

Refuge and Natural Areas - The following refuge and natural areas are found in pools 8 and 9. These are significant resources because they have been identified by State and Federal officials as being areas which should be managed to maintain the existing biological resources.

1. The Upper Mississippi River Wild Life and Fish Refuge (U.S. Fish and Wildlife Service) covers much of the floodplain in the study area.

2. West Channel Woods Natural Area (Wisconsin DNR) located just south of La Crosse.

3. Waller Lake Floodplain Forest Natural Area (Wisconsin DNR) located [illegible] miles south of Genoa.

4. Lower Goose Island Natural Area (Wisconsin DNR), a floodplain area located in the northwest corner of Vernon County.

5. Turtle Nest Islands, Forsters Tern Colony, Crosby Slough Natural Areas (Wisconsin DNR), located just outside of Stoddard, Wisconsin.

6. Mouth of Rush Creek Natural Area (Wisconsin DNR), located immediately west and northwest of Ferryville, Wisconsin.

Endangered and Threatened Species

Consultation will be initiated during the feasibility study to determine which endangered and threatened species might be found in the vicinity of the project. Information will be requested from the U.S. Fish and Wildlife Service and the Wisconsin and Minnesota Departments of Natural Resources. An assessment of potential impacts will then be made.

Significant Facilities

The following two facilities are listed as significant because of their close proximity to lock and dam 8 and their reliance on river water for continued operation. The nuclear power plant at Genoa uses river water in its cooling system, and the National Fish Hatchery 4 miles below lock and dam 8 requires river water for its operation.

Cultural Resources

The Mississippi River valley has been occupied from early prehistoric human periods (approximately 12500 B.C.) to the present. Indian villages were generally situated along the valley floor, and burial mounds were usually built on the bluff tops. Historically, the valley has been a witness to the earliest European and American explorers, traders, and settlers.

There are three recorded archeological sites within three-fourths of a mile from lock and dam 8, in the Mississippi River valley. These sites are: the River Road Mounds (47-Ve-11), the Genoa Mounds (47-Ve-10), and an unnamed mound group (47-Ve-8). The cultural affiliation of these mounds is unknown. As of 28 August 1981, no sites currently on or eligible for the National Register of Historic Places are located in the immediate lock and dam area.

Recreation

The most significant recreational resource in the lock and dam 8 area is Reno Bottoms. It is considered one of the most significant and important sport fishery and waterfowl resources on the Upper Mississippi River. It is estimated that pool 8 (including Reno Bottoms) supported 1,422,000 hunting and fishing occasions in 1980. The area also supports a considerable amount of boating, estimated at 282,000 activity occasions in 1980.

LITERATURE CITED

Minor, J. M., L. M. Caron, and M. P. Meyer, 1977. Upper Mississippi River Habitat Inventory. IAFHE RSL Res. Rept. 77-7, Phase III. USFWS Serv. Contr. No. 14-16-003-30, 686.

Rasmussen, J. L. ed., 1979. A Compendium of Fishery Information on the Upper Mississippi River. Upper Mississippi River Conservation Committee.

U.S. Army Corps of Engineers, 1974. Final Environmental Impact Statement - Operation and Maintenance, 9-Foot Navigation Channel, Upper Mississippi River Headwaters of Navigation to Guttenberg, Iowa. St. Paul District.

ENVIRONMENTAL EFFECTS

The following is a general discussion of the impacts of construction and operation of a hydropower installation at lock and dam 8. Potential impacts of the action are discussed but a detailed analysis has not been made.

NO ACTION ALTERNATIVE

There should be no direct impact on the existing natural resources of pools 8 and 9 if hydropower was not installed on lock and dam 8.

10-UNIT ALTERNATIVE

Construction Impacts on Natural Resources

A single option for the installationof hydropower is evaluated in this report. This would be the placement of 10 tube-turbine generating units in the bulkhead storage yard on the west end of the dam. An alternative which utilized the placement of "lift-out" turbines in the tainter gates was found not feasible because of structural and foundation considerations. New alternatives which would use this approach will be formulated and evaluated during the feasibility study. Impacts would likely be similar to those of alternatives evaluated in this and other reconnaissance reports that require cofferdams for construction.

The alternative that was feasible would require excavation of headrace and tailrace channels through the land area used for the storage of bulkheads used in the maintenance of the dam. Cofferdams would be placed around the channel ends to permit dry excavation. Dry excavation permits the stabilization of the channel sides and bottom so as to minimize increases in turbidity when the channel is filled with water. The placement and removal of cofferdams has the potential for increasing turbidity and sediment deposition for short periods of time. It would be necessary to properly treat and dispose of seepage water removed from inside the cofferdam. Habitat for benthic organisms would be covered by placement of cofferdams. Finally, it would be necessary to dispose of cofferdam material in a suitable upland site to avoid adverse aquatic or wetland impacts.

Noise which would result from the operation of construction equipment may be an irritant to people hunting or fishing near the project.

Wildlife habitat, including vegetation, may be disturbed near the construction area depending upon the amount of space required for construction equipment access, movement, and storage.

Because there is no road access to the site, it would be necessary to construct barge landings on both sides of the river to permit the movement of construction equipment across the river. The extent of the potential impacts of this action will be evaluated during the feasibility study. The removal of these landings would require similar considerations as removal of the cofferdams.

The construction of a transmission line corridor across to the Minnesota side of the river could have substantial effects on the wetlands through vegetation clearing and soil disturbance. Placing elevated transmission lines above the dam or across the Reno Bottoms would constitute a hazard to migratory waterfowl. Because of the Genoa Nuclear plant, much less new transmission line construction would be anticipated on the Wisconsin side.

Operation Impacts on Natural Resources

Hydropower at Mississippi River locks and dams would be operated on a "run-of-the river" basis. No storage of water and no pool fluctuations would occur. It is anticipated that impacts would be confined to the immediate vicinity of the dam.

Water quality would not be diminished by operation of hydropower turbines. However, the turbulence which presently occurs when water passes over the dam would no longer occur when all water passed through turbines. It is likely that, if it proves necessary, structural means of reestablishing the aeration would be possible.

Impingement of adult fish, eggs, or larvae would not be expected because trash racks or screens would have relatively large openings. Although approach velocities have not yet been calculated, entrainment is not expected to be a problem. Mortality of fish passing through the turbines would occur but is expected to be minimal because of the expected low pressure and speed and relatively large clearance between the turbine blades and the tube.

The tail-water areas of the dams generally provide good to excellent quality aquatic habitat. This alternative would result, during certain periods, in the diversion of nearly the entire river flow through the turbines. The distribution of flows, current velocities, and sediment would change. The effect of these changes is unknown and would be investigated during the feasibility study.

The diversion of much of the flow through turbines may interfere with the upstream movement of fish. Little is known about this phenomenon in the Mississippi River. The fish, such as sauger or white bass are not considered to be migratory in the same way as salmon. Further study would be required to determine the extent and significance of impacts resulting from interference with upstream movement of fish. It can be noted, though, that because of small head differentials there would be no power generation at the times when fish could most easily cross the dam.

Any maintenance dredging of intake or outflow channels would destroy benthic organisms and have the potential for causing elevated turbidity and sediment deposition. It would be necessary to control turbidity and to find suitable sites for the disposal of excavated material.

Impacts on Cultural Resources

Much of the proposed construction area for the installation was previously disturbed by the construction of lock and dam 8. There is still the possibility that historical and/or archeological sites will be negatively affected by operations related to the hydropower development. The construction of barge landings on either or both sides of the river may have adverse impacts. The r. d for further cultural resource work will be determined during later planning stages in consultation with the appropriate State Historic Preservation Officers and State Archeologists. Project coordination has been initiated with the Wisconsin and Minnesota State Archeologists, the Minnesota and Wisconsin State Historic Preservation Officers, and the National Park Service.

Impacts on Recreation Resources

Any project-induced change of the inflow to Reno Bottoms would have a significant negative effect on hunting and fishing. Alternatives which would directly affect Reno Bottoms water flows were rejected.

The proposed development should not significantly affect general boating in the area.

A privately owned fishing float is presently located approximately 100 feet below the dam. Fishermen are transported across the river by boat by the owner of the float. High current velocities resulting from the diversion of flow may require that the float be relocated. At a minimum, the change in current velocity may diminish the quality of sport fishing at the float. This will be further investigated during the feasibility study.

ME

8